TAMPERE UNIVERSITY OF TECHNOLOGY

Laura Perko

BUSINESS NEEDS FOR A WAREHOUSE MANAGEMENT SYSTEM

Master of Science Thesis

Examiner: Samuli Pekkola
Examiner and topic approved by the Faculty of Business and Built Environment
on 9th October 2013

ABSTRACT

TAMPERE UNIVERSITY OF TECHNOLOGY
Master's Degree Programme in Knowledge Management
PERKO, LAURA: Business needs for a warehouse management system
Master of Science Thesis, 61 pages, 47 Appendix pages
May 2017
Major: Business Information Management
Examiner: Prof. Samuli Pekkola
Keywords: Information Systems, Warehouse Management

The study is based on a need in the case company for a new warehouse management system. The case company is a globally operating logistics service provider offering a wide range of services such as warehousing. The goal of the study was to find out the current and future business needs for a warehouse management system so that more precise requirements for this information system can be defined. The research method is one case study with multiple units of analysis inside the case company.

The study consists of a theoretical and an empirical part. The theoretical part is based on theory about warehousing, warehouse management information systems and logistics outsourcing which is the core business of the case company. The theory constructs the basis for the requirements that warehousing and logistics outsourcing set for the warehouse management system. The empirical part comprises of two surveys and interviews. The surveys were designed on the basis of previous surveys in the company, the theoretical part of the research and using the expertise of the case company logistics management. The interviews were based on the survey answers and aimed to widen the knowledge about the business of the company and the business needs for the warehouse management system. The surveys were piloted in one business unit in the company and later in all of the business units of the company during the summer of 2011. After initial processing of the survey answers open interviews were conducted with the management of business units logistics and IT. After the analysis of the research material the criteria for defining a priority list for evaluating warehouse management systems was developed in close cooperation with logistics management of the case company. The priority list consists of warehouse management system features with three priority levels. The primary features include the absolute basic needs that the system in question needs to fill and the secondary and tertiary features that can be used in selecting the system candidates for further evaluation.

TIIVISTELMÄ

TAMPEREEN TEKNILLINEN YLIOPISTO
Tietojohtamisen koulutusohjelma
PERKO, LAURA: Liiketoiminnan tarpeet varastonhallinnan tietojärjestelmälle
Diplomityö, 61 sivua, 47 liitesivua
Toukokuu 2017
e Pääaine: Tiedonhallinta
Tarkastaja: prof. Samuli Pekkola
Avainsanat: Tietojärjestelmät, Varastonhallinta

Tämä tutkimus pohjautuu tarpeeseen hankkia case-yritykseen uusi varastonhallinnan tietojärjestelmä. Caseyritys on kansainvälisesti toimiva kolmannen osapuolen logistiikkayritys joka tarjoaa asiakkaalleen laajoja logistiikkapalveluita varastonhallinnasta lähtien. Tutkimuksen tavoitteena oli selvittää yrityksen nykyisen ja tulevaisuuden liiketoiminnan tarpeet varastonhallinnan järjestelmälle, jotta järjestelmälle asetettavat vaatimukset pystytään sen pohjalta tarkemmin selvittämään. Tutkimusmenetelmänä on yhden casen tutkimus jossa on mukana monta itsenäistä yksikköä caseyrityksen sisällä.

Tutkimus koostuu teoreettisesta ja empiirisestä osiosta. Tutkimus pohjautuu teoriaan varastonhallinnasta, sen tietojärjestelmistä sekä logistiikan ulkoistamisesta, joka on case-organisaation ydinliiketoimintaa. Teoriaosuus rakentaa pohjaa vaatimuksille, joita varastonhallinta sekä logistiikan ulkoistaminen liiketoimintana asettavat varastonhallinnan tietojärjestelmälle. Empiirisessä osuudessa tutkittiin kahdella kyselyllä sekä niitä tarkentavilla haastatteluilla yrityksen liiketoiminnan erityispiirteitä, jotka heijastuvat varastonhallinnan tietojärjestelmään. Kyselyt suunniteltiin käyttäen apuna yrityksessä aikaisemmin suoritettuja selvityksiä, teoriaa sekä yrityksen logistiikkajohdon asiantuntemusta. Kyselyt pilotoitiin ensin yhdessä liiketoimintayksikössä ja lähetettiin liiketoimintayksiköihin kesän 2011 aikana. Kyselyvastausten alustavan läpikäynnin jälkeen suoritettiin avoimet haastattelut liiketoimintayksiköiden logistiikka- ja IT-yhteyshenkilöiden kanssa. Koko caseaineiston analyysin jälkeen caseyrityksen johdon kanssa määriteltiin kriteerit, joilla muodostettiin tutkimuksen lopullinen tulos eli prioriteettilista varastonhallinnan tietojärjestelmään tarvittavista ominaisuuksista. Lista määrittelee hankittavaan tietojärjestelmään ehdottomasti tarvittavat ominaisuudet eli primaariset ominaisuudet sekä sekundaariset että tertiaariset ominaisuudet, joiden avulla voidaan rajata mahdollisia järjestelmäkandidaatteja pois jatkoarvioinneista.

PREFACE

I began working on this thesis in 2011 commissioned by an international logistics company. The purpose of the study was to find out the requirements for a new Warehouse management system and as a student concentrated on information systems and IT management I was naturally interested on the subject. The actual study consisted of two parts including WMS evaluation. It was executed during very busy six months and the first report was submitted in fall 2011. Finishing the thesis has been a longer process, defining the thesis to include only part of the original subject thus writing the final version has taken quite a time. Life has also happened, but this thesis is here and now.

I would like to thank my supervisors in the company for giving me an opportunity to be a part of this project and explore international business. I wish the company all the best and hope that this study will be of use in the future projects. Am truly grateful for my professor Samuli Pekkola, who has been encouraging and patient during all these years. This has been an arduous process but finally it is time to turn another page in my life. I sincerely thank Miko and my parents for supporting me and everyone who have encouraged me during all this time.

Helsinki, 20.5.2017

Laura Perko

CONTENTS

TERMS AND DEFINITIONS

3PL	Third-Party Logistics
4PL	Fourth-Party Logistics
ASN	Advance shipment notification
AS/RS	Automated storage and retrieval systems
BBD	Best before date
CKD	Complete knock-down or complete kit needed to assemble a product
DSS	Decision Support System
EAI	Enterprise application integration
EDI	Electronic data interchange
ERP	Enterprise Resource Management System
FMCG	Fast-Moving Consumer Goods
IT	Information technology
JIS	Just In Sequence, an inventory strategy
JIT	Just In Time, an production strategy
LIS	Logistics information system
LSP	Logistics service provider
RF	Radio frequency communications
RFID	Radio-frequency identification
SAD	Single administrative document
SKD	Semi knock-down or incompletely disassembled kit needed to assemble a product
SKU	Stock-keeping unit
TMS	Transportation Management System
TTS	Track and Trace System

VMI	Vendor-Managed Inventory
VAL	Value-Added Logistics
WMS	Warehouse Management System, a software built for warehouse operations and management.
XML	Extensible Markup Language

1. INTRODUCTION

Traditionally a Warehouse Management System (WMS) has been an information system that enables the basic operations in a goods distribution system. During years it has evolved into a tool which controls a complex system, controls the performance and optimizes the processes of the warehouse (Ten Hompel and Schmidt, 2007, p. 4). Through the 1980's and 1990's companies usually developed a custom-made WMS for their warehouse operations, but in the last 10 years the standard warehouse management software has become popular due to its fast implementation time. (Van den Berg, 2007, p. 83). The situation has changed again as the companies have turned to contract logistics (Robeson and William, 1994, p. 508), which is usually referred as third party logistics. Companies are outsourcing their logistics functions and do not need a WMS of their own anymore. In turn, the contract logistics suppliers need information systems to serve wider purposes and operations.

PwC (2016) report indicates that the logistics industry is highly competitive and the customer expectations are ever increasing. Logistics service providers constantly need to develop new strategies and provide cost-effective services to keep up with the market. Davarzani and Norrman (2015) state that having customers who expect more means developing customized services and catering to requirements such as big fluctuation in demand and order consolidation. Advanced IT strategies support flexibility through the organization thus enabling the company to meet customer needs efficiently (Zakery, 2011).

Financial performance is linked with IT capabilities of logistics service providers (Lai et al., 2007; Liu and Lyons, 2011; Wang et al., 2008). Typically IT is used for enhancing performance but it can also be utilized as a strategic resource. Wong and Karia (2010) argues that information technology should be seen as a strategic capability for logistic service providers. Aligning the IT strategy with business strategies and building better IT capabilities provides competitive advantage in logistics service variety and service quality (Lai et al., 2007). Thus business strategies should be considered when acquiring new information systems for the organization.

The case company is an international enterprise that offers tailored supply chain

services for customers. Contract logistics is an essential part of this business and the supporting information systems must enable planning and management of global supply chains. The warehouse management system is a key part of their information systems that enables warehouse operations and planning. The case company launched its WMS project in March 2011 and this study was part of the project. The motivation for the project was the search of new business opportunities, keeping up with the corporation IT developments and limiting the number of different WMS systems inside the business units.

The company has several business units which serve different types of customers. The object of the WMS project is to reduce the warehouse management systems used within the company to two different supported systems. The project schedule was driven by the need of a replacement system in one of the business units. The first implementation of the new WMS was executed in this business unit.

The study was the first step in the project and its role was to be a preliminary study for the selection of the WMS software. The goal of the study was to understand the current and the future business needs of the different business units that eventually set the requirements for the WMS. The study comprises of a theoretical part and an empirical part consisting of two surveys and additional interviews and discussions with the management of the business units and IT.

1.1 Purpose of the study and research questions

The objective for the study was to define what kind of needs or requirements the current business has for the Warehouse Management System and the requirements that pursuing new clients in different business areas set for the system in the future. Thus the main research question of the study is defined as follows:

- What kind of current and future business needs the company has for the WMS?

To define the business needs of the company in more detail they are translated to requirements for the WMS. The main research question can be divided to three sub-questions that direct the design of the study and analysis of the results.

1. What kind of requirements do the general warehouse operations set for the WMS?
2. What kind of requirements do the specific business areas set for the WMS?

3. What kind of requirements do internal operations set for the WMS?

The first sub-question aims to define the basic WMS requirements and the second examines the requirements that arise from the needs of the different customer types. The third sub-question pursues to determine the requirements that derive from the internal operations of the case company. The study is divided in two parts, the first studying the first sub-question of general warehouse operations and the second combining the two latter sub-questions.

1.2 The scope of the study and limitations

The thesis consists of two parts: the underlying theory and the empirical part which is constructed as an embedded single case study. The theory is constructed from three parts: warehousing, warehouse management systems and third-party logistics. The examination of these topics aims to search what kind of business needs warehousing, international supply chains and outsourcing set for warehouse management systems. Thus an introduction to warehousing and warehouse operations is necessary to understand the context where the warehouse management system is used. Warehouse operations also provide the general functionality requirements for the WMS.

The second part of the theory examines more closely the information system in question, its functionality and role in the supply chain. The last theoretical part concerns third party logistics. 3PL is the case company's business domain which sets additional requirements to the warehouse management system.

The aim of the empirical part is to examine how the case company operates and what kind of needs it has for a warehouse management system. The empirical part is divided in three parts: two surveys and an interview part which was dependent on the survey answers and meant to deepen the knowledge about the specific needs of the business units. The first survey is the general warehouse operations survey. This reflects the current business needs for the WMS and also defines the future needs in the operational level. The second survey is the customer and internal operations survey, which aims to identify the needs of specific business areas and the needs that arise from internal operations which do not belong to the basic warehouse processes.

In addition to 3PL specific processes in warehousing serving the different customer types of logistics service providers demands additional flexibility from the WMS. In the logistics industry functionality such as track and trace is defined as basic requirement for the WMS while integrating the IT capabilities with internal and external

processes is considered a unique capability (Wong and Karia, 2010). Pursuing new business opportunities while improving existing services is an important objective for the case company. Serving different types of customers means the WMS has to be able to respond to the specific needs of the different business areas. Additionally, serving customers means also refining the internal non-customer specific operations in order to provide high-performance services at affordable prices.

In the case company there is a presumption that the general warehouse operations' requirements for a WMS are the same in all of the business units as the WMS systems in use have the same basic functionality. However the purpose of this study was not to make assumptions based on the previous information systems but to find the real business needs which define the features required in the WMS. The general warehouse operations was the part of the study which participants are most familiar with as they are responsible for the operational level in the business units. The first survey prepared the participants to the second survey in which they had to define the customer-specific needs, evaluate the future business opportunities and improving internal operations.

After the surveys the results were examined and based on the survey data the business unit representatives were interviewed. The aim was to clarify the answers and to develop deeper understanding of the business units and their needs. Eventually the goal of the empirical part was to realize these needs as a warehouse management system feature list which can be used as a guideline in the case company in the selection process of a new WMS. This study focuses on the warehouse management system functionality and does not take into account the information technology architecture in the participating business units. The purpose of this thesis is to build an understanding of the business needs that drive the selection of the new warehouse management system. To ensure that both the specific needs of the daily warehouse operations and the future business plans are covered, the study includes participants from the business unit logistics and IT departments.

1.3 Methodology

In business economics research the two main research philosophies are positivism and social constructivism. The positivistic approach focuses in statistical information and views the researcher as an independent organism with no connection to the research object. The aim of the research is to explain causal relations between phenomenons by researching a large group of instances. Social constructivism aims to interpret the reality through social and human interest which leads to deeper understanding of the research object. Social constructivism uses typically a small

amount of cases that are selected by their suitability to the research. (Koskinen et al., 2005, p. 33-35). This research leans more to social constructivism, as it relies heavily on empirical research.

The research approach can be seen as a constructive approach. According to Lukka (2000) the core features in constructive research require that the research:

- concentrates on real-life problems that are essential to solve in practice
- produces an innovative construction intended to solve the original real-life problem
- includes an execution attempt of the construction
- implies a close team approach of the researcher and representatives of the practice which includes learning from experience
- is linked into already existing theoretical knowledge and
- takes into account reflecting the empirical findings back to the theory.

Constructive research is a suitable research approach as this study relies on solving a real-life problem and aims to produce an answer, a feature list that can used to select a suitable warehouse management system candidate for further evaluation in the WMS project. The nature of the study demands collaboration with the researcher and experts in the case company. The basis for the study is the underlying theory about warehouse management and the core business, third party logistics, and in the end of the study the results of the empirical part will be linked back to the theory.

According to Yin (2003, p. 3) there are five different research strategies: experiment, survey, archival analysis, history and case study. These strategies can overlap but they have distinctive characteristics which helps to choose the right research strategy. Yin (2003, p. 7) suggests choosing the research strategy according to the type of research question asked. Case study is a suitable strategy when the research question focuses mainly on "how" or "why" questions. Case study is also recommended if there is no need for control over behavioral events and the degree of focus is on contemporary events as opposed to historical events. (Yin, 2003, p. 5-9) This research aims to describe how the case company does business and how it affects the warehouse management system functionality. The focus is on current and future business but there is no control over behavioral events. Thus case study is a suitable

research strategy for this research. Yin (2003, p. 8) adds that the strength of the case study is in multiple sources of evidence, as the case study adds observation of the events and interviews of the persons included in the events to the sources of evidence. This research also utilizes these sources in the form of documentation of the current business processes and interviews of logistics and IT representatives. Defining a case study as a research method has historically been a difficult task. However, it has distinctive characteristics, as described by Yin (2003).

- Case study investigates a contemporary phenomenon inside its context in real life.
- The boundaries between the context and the phenomenon are not clearly evident.
- Case study inquiry deals with a situation where there are many more variables of interest than data points.
- Case study relies on multiple sources of investigation which can support each other's results.
- Case study benefits from existing theoretical propositions to guide data collection and analysis.

The case study includes several sources of information. Yin (2003, p. 86) lists six sources of case study evidence: documentation, archival records, interviews, direct observations, participant-observation and physical artifacts. This case study combines both quantitative and qualitative information. According to Yin (2003, p. 91) the survey is a suitable data collection method as a part of a case study. However in the case study the quantitative data is not considered to represent absolute fact but it is analyzed in relation to other sources of evidence (Yin, 2003, p. 91). Koskinen et al. (2005, p. 62) note that the information collected from surveys can be considered as factual information as the survey answers should be considered honest and open views of the person who answers the questions. This study uses surveys, documentation, archival records and interviews. The documentation and archival records have an important role in acting as supportive data for designing the surveys and interviews. The underlining theory is used to support and guide the construction of the surveys and it plays an important part in the analysis of the case study material. The results of the empirical part of the study are organized and interpreted with the help of the theoretical part.

In this study the aim of surveys is to find a set of specific Warehouse Management System features which help to describe and concretize the business requirements. The interviews and discussions with the business unit representatives enables the construction of a wider perspective of the business and its characteristics. This study uses also historical data and surveys made in the previous WMS projects in the company, definitions of the current processes and other documentation. This study can be defined as a single-case study which includes multiple units of analysis. Yin (2003, p. 43) calls this type of research an embedded single case study design, as it includes several units of analysis inside the same context. In this research the units of analysis are the different business units inside the company.

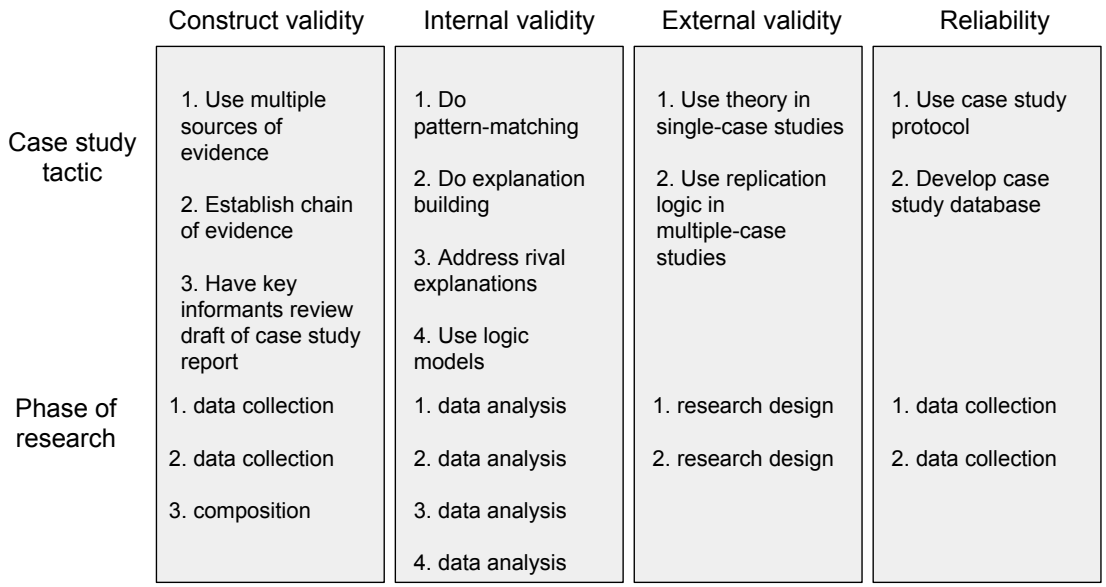

Figure 1.1: Case study tactics for four design tests, adapted from Yin (2003, p. 34)

Case study quality has four different tests which are shown in Figure 1.1. In the final chapter of this thesis these tests will be used to evaluate the study. In simple terms construct validity describes whether the study actually investigates what it is supposed to investigate. Farquhar (2012) notes that this assumes objective reality which is problematic in case study - the nature of case study is often interpretive and the researcher cannot isolate themselves from the phenomenon that is happening. Yin (2003) notes that in the case study there are three ways to ensure construct validity: using multiple sources of evidence and establishing a chain of evidence when collecting data and having the key informants review a draft of case study report during the composition of the case. Using multiple sources of evidence aims to ensure that the same result can be observed from multiple directions or triangulated. A chain of evidence means showing how the researcher went from research question to conclusion (Farquhar, 2012). Letting the key informants review a draft of the case

study report is a means of validating the facts which means that the informants and the researcher should not disagree on these (Yin, 2003, p. 159).

Farquhar (2012) describes internal validity as the causal relationships between variables and results, which in the case study means being able to persuade the reader that the findings are based on critical investigation of the case study data. Yin (2003, p. 34) notes that internal validity tests are only applicable in the case of causal case study. Ensuring internal validity happens during the data analysis phase of the case study and includes pattern-matching, explanation building, addressing rival explanations and using logic models.

External validity depends on the type of the case study and concerns the research design phase. Using theory for designing the research is necessary in single-case studies and in multiple-case studies the study is designed by using replication logic. External validity can also be translated as generalizability (Farquhar, 2012). In the single-case study the data should be able to be connected to a pre-existing theory. Yin (2003, p. 34) calls this theory as the domain of which the case study's findings can be generalized. Another term for this is analytic generalization (Farquhar, 2012).

Case study reliability can be tested by using the case study protocol and developing a case study database during the data collection phase. In simple terms reliability means that repeating the research it should be possible to arrive to the same conclusions (Farquhar, 2012). Yin (2003) notes operations of the research like data collection methods, must be able to be repeated. To achieve this the data collection methods have to be documented carefully.

1.4 Structure of the thesis

Chapter 1 of this thesis acts as an introduction to the case company, research propositions and methodology. First there is an introduction to the case company and the project which led to this research. Next the object of the study is defined and research questions are formulated. Then the scope of the study is defined and limitations to the study are discussed. After this the research philosophy and the research strategy are described and the methods for ensuring the quality of the study are introduced. Finally there is an overview of the thesis.

Chapter 2 concentrates on the underlying theories of the study. First the domain, logistics, is briefly introduced. The next subchapter focuses on warehousing which is the operational domain of this thesis. Warehouse activities are introduced and then the strategic dimension of warehousing and its challenges are discussed. Next

subchapter focuses on the information system used to control and plan activities in the warehouse. An overview of information technology in warehouses is introduced and then the warehouse management system functionality is described in detail. After this research into benefits of using warehouse management systems is discussed and finally the significance of IT capabilities in warehousing is presented. The next subchapter concentrates on the business domain of the case company, which is contract logistics. The business of logistics service providers is explained and the motivation to outsource logistics is also addressed. Finally research IT capabilities of logistics service providers is depicted.

Chapter 3 describes the design and execution of the case study. First a detailed description of the case company is portrayed. Then the construction of the study is explained and all the activities executed during the study are described in detail. Finally initial criteria defined for compiling the WMS recommendation which is the main motivation for conducting this thesis is determined.

In Chapter 4 the results of the case study are described in detail from several points of view. The first segment describes the results of the surveys. It is divided after the research questions and presents the WMS functionality according to warehouse operations and management. Next the results are displayed from the viewpoint of company business units which can be treated as separate units of analysis. This takes into account all the case study material that was available: surveys, interviews and historical information. Final section incudes the WMS recommendation which wraps up the results of the study.

The final conclusions are presented in Chapter 5. First the individual research questions are reviewed. Then there is a final evaluation of the study and the case study quality tests which were introduced in the Chapter 1.3 are revised. Finally a recommendation for further research is presented.

2. THEORIES BEHIND THE STUDY

The theoretical part of this study discusses three topics: warehousing, warehouse management system and contract logistics. The topics are related together as shown in Figure 2.1.

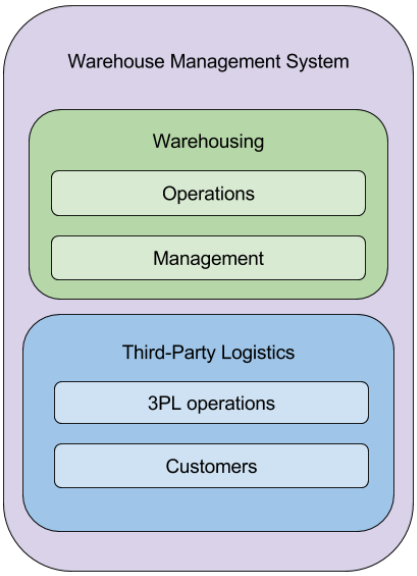

Figure 2.1: The theoretical topics.

The core component in the study is the warehouse management system which is the most important information system in warehouse operations and warehouse management. In addition to the information system and the operations it is used for the theory covers the domain of the case company. The business itself, third party logistics, sets requirements to the information system as the warehouse environment changes compared to a normal warehouse system. The objective of the theoretical part is to examine all the topics that affect the business needs for a WMS.

2.1 Logistics

Logistics can be defined as the way of dealing with the movement and storage of materials or products which results in a higher consumer satisfaction (Farahani et al., 2011). A more detailed definition for logistics is the efficient transfer of goods from the source of supply through the place of manufacture to the point of consumption in a cost effective way whilst providing an acceptable service to the customer. The major components of logistics can be divided to transport, warehousing, inventory, packaging and information. (Rushton et al., 2010) The components can be further divided to more detailed topics shown in Figure 2.2.

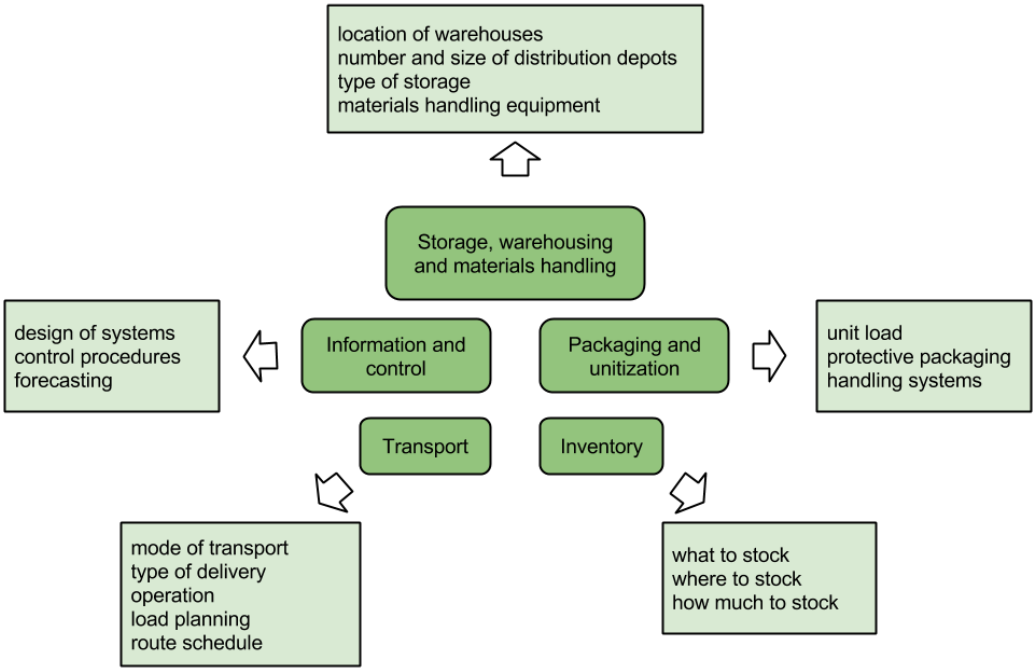

Figure 2.2: The major components of logistics in detail, adapted from Rushton et al. (2010).

These functions need to be planned in a systematic way taking into account the local environment and the wider scope of the distribution system (Rushton et al., 2010). The topic of warehousing will be discussed in more detail in Chapter 2.2. However it is important to notice that all the major components of logistics are interrelated (Rushton et al., 2010) so they need to be taken into account at some level when defining the business needs for a warehouse management system, which is the main objective for this thesis.

2.2 Warehousing

Warehouses are an essential part of the supply chain. Traditionally the role of warehouses has been inventory holding and servicing customer orders from the inventory (Baker, 2007, p. 65-66). In 2004 warehousing contributed to 24 per cent of logistics costs (De Koster et al., 2007). Baker (2007) argues that research has challenged the necessity of inventory and warehouses as part of inventory holding by highlighting the costs of inventory and process of inventory holding in slowing down the supply chain flow. However, warehouses are almost inevitable in a logistics system (Dolgui and Proth, 2010). Other roles of warehouses besides inventory holding have become increasingly important for the supply chain as they have changed from being holding yards to switching yards (Baker, 2007)

De Koster et al. (2007) use the term warehouse if the main function is buffering and storage but the term can be expanded to distribution, transshipment, cross-dock and platform centres. In a modern supply chain warehouses are used for storing or buffering products at and between points of origin and consumption. Dolgui and Proth (2010) describe warehouses as a bridge between upstream and downstream activities in the supply chain. They work for accommodating variability caused by seasonality and relative slow supply chain response to changing demand, meeting the customers' requirements by value-added processing and consolidation of products from various suppliers for combined delivery to customers (Gu et al., 2007; Dolgui and Proth, 2010).

Dolgui and Proth (2010) list a number of benefits for using warehouses in a supply chain. Supply chain complexity, quality problems and long-duration or unreliable transportation systems lead to slow supply chain response to rapid change in quantities ordered. Warehousing enables a quick reaction to variability in demand and favors upstream production systems by allowing them to increase the lots. This reduces both production and distribution costs. Warehouses enable mass customization by offering the possibility to configure and assemble products as near as possible to the customer, which is common in the computer and furniture industries. Products can be also repackaged for different retailers or customers and reorganized for transportation purposes. Manufacturing industries benefit from additional operations like inbound inspections, part preparation and kitting. These are completed in warehouses before the next step manufacturing or assembly process. Warehouses allow the food industry to have a wide assortment of products which customers can purchase in small quantities of many different products at low prices. For retailing groups warehouses can supply the seasonal production as required. Warehousing also protects against technical glitches and security threats and enables price sta-

bility since scarcity in the supply of goods can increase prices. (Dolgui and Proth, 2010)

As noted earlier, warehouses can have a number of roles other than inventory holding. The different roles in the supply chain can be classified into these categories: consolidation centers, cross-dock centers, transshipment facilities, assembly and postponement facilities, product-fulfillment centers, returned goods depots and as parts of the production process (Baker, 2007; Farahani et al., 2011; De Koster et al., 2007; Rushton et al., 2010). In consolidation centers a number of products are brought together either from the storage or different parts of the supply chain for consolidation into one delivery to the customer (Baker, 2007). In cross-dock centers the goods are brought in from another source to fulfill a customer order and go directly through the cross-dock facility into shipment without being placed into storage (Rushton et al., 2010). Transshipment facilities are used to change transport mode from large line-haul vehicles to smaller delivery vehicles (Baker, 2007; Farahani et al., 2011). The final configuration of the product according to individual customer requirements takes place in an assembly facility so that the production can be postponed as far as possible down the supply chain in order to minimize inventories (Baker, 2007; Rushton et al., 2010). Product orders are delivered directly to the end customer from product-fulfillment centers (Baker, 2007) and returned goods depots handle customer returns and damaged goods and driven by environmental legislation also the recovered packaging waste and product recovery (Baker, 2007; Rushton et al., 2010). Warehouses have also a role in the production process for products like cheese and wine that need to be in a climate-controlled environment for a certain time before the product is finished (Farahani et al., 2011).

2.2.1 Warehouse activities

Gu et al. (2007) defines the basic functions of the warehouse as receiving stock-keeping units or SKUs from suppliers, storing SKUs, retrieving them from storage and assembling for shipment and shipping the completed orders to customers. Retrieving stock-keeping units from storage is normally referred to as order picking (Rouwenhorst et al., 2000). Storing stock-keeping units can also be referred to put-away (Rouwenhorst et al., 2000) or handling (Gunasekaran et al., 1999). The warehouse functions are described in more detail in Figure 2.3.

In the receiving phase the goods that arrive into the warehouse are delivered by trucks which are unloaded at receiving docks. Before the delivered loads are prepared for transportation to the storage area the inventory is updated, quantities are verified and random quality checks are performed on the loads (van den Berg and Zijm, 1999;

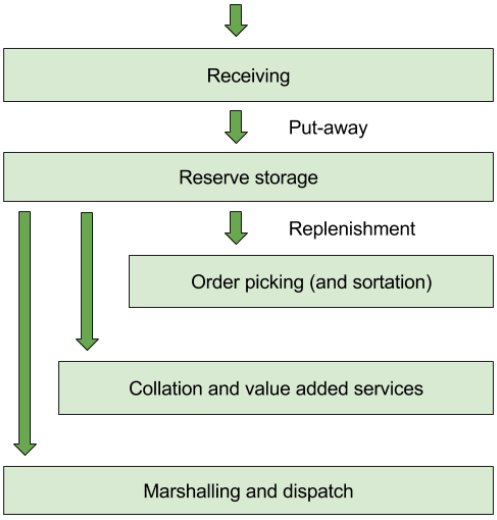

Figure 2.3: Typical warehouse functions in a stock-holding warehouse, adapted from Rushton et al. (2010).

De Koster et al., 2007). Next the goods are transferred and put away into storage location (De Koster et al., 2007).

The storage location is typically divided in two parts, reserve storage and forward area. (Rouwenhorst et al., 2000) In reserve storage goods can be organized into departments to achieve efficient material handling and high space utilization. Department organization can be made according to physical characteristics of goods, dedicated areas to specific customers and material handling considerations. (Gu et al., 2007) The purpose of the reserve area is to store the goods in the most economical way and the forward area where products are stored for easy retrieval by an order picker. Forward area can also be called a staging area in which case also incoming goods can be temporarily transferred there before before being placed in the storage. Transferring goods from the reserve storage to the forward storage is called replenishment (Rouwenhorst et al., 2000). Goods can also be taken straight to the marshalling if for example a customer has ordered a full pallet (Rushton et al., 2010).

Order picking is the process of retrieving items from storage according to a specific

customer order (Manzini, 2011). A customer order is a list of the stock-keeping units and quantities requested either by a customer or a production or assembly workstation in the case of a distribution center or a production warehouse (van den Berg and Zijm, 1999). Smaller orders can be picked in batches in which case it is necessary to sort the picked orders into individual customer orders by grouping the picked goods (De Koster et al., 2007). According to De Koster et al. (2007), De Koster and Warffemius (2005) and Rushton et al. (2010) order picking is the major activity in most warehouses in terms of cost and labor. Manzini (2011) notes that order picking typically accounts for 55 percent of warehouse operating costs.

Collation means assembling and packing the goods together into complete customer orders after picking. In some cases the goods can be picked directly into the dispatch containers like roll cages or cartons hence collation of the goods is not necessary. During the collation phase the goods may be passed to a packing station where they are packed into a carton, which is then shrink-wrapped onto a wooden pallet for transit. This process can also involve production postponement activities and other value added services like kitting and labeling. (Rushton et al., 2010) De Koster and Warffemius (2005) divides the value added logistics (VAL) services to low-end and high-end according to the value they add to the product. Low-end VAL include labeling, adding manuals and kitting. High-end VAL includes activities such as sterilization, final assembly and installation (De Koster and Warffemius, 2005). Most warehouses also provide additional services like inventory holding of packaging material, promotional packaging and refurbished or returned goods (Rushton et al., 2010). In simplified warehouse processes the collation process is integrated into the shipping function (Manzini, 2011).

In the shipping function goods are marshalled together to form loads in the dispatch area and loaded onto transport vehicles for onward dispatch to the next part of the supply chain (Rushton et al., 2010). If the received products have only short stays or services in the warehouse but no order picking is needed the received products can be transferred directly to the shipping docks. This is called cross-docking. (De Koster et al., 2007) Cross-docking can also be described as bypassing the put-away and storage process so the shipments to a same destination can be combined (Min, 2006).

Warehouse operations have several challenges as presented by Gong and de Koster (2011). The put-away process determines the efficiency and cost of retrieving the goods from the storage and accounts 15 percent of warehouse operational cost (Gong and de Koster, 2011). Direct put-away removes the staging and inspection activities but at the same time increases uncertainties since potential errors cannot be

identified in time. A warehouse management system can direct put-away activities whereupon efficiency is improved by maximizing location and cube utilization and retrieval productivity. Batching and sequencing at put-away can also improve efficiency. (Gong and de Koster, 2011). Gu et al. (2007) describes sequencing as planning the order in which a given set of items are stored.

In the storage a forward-reserve-strategy improves the efficiency of order retrieval and picking (Gu et al., 2007; van den Berg and Zijm, 1999). The aim of the reserve area is to utilize the space efficiently and reduce the uncertainty of replenishment to the forward area. The forward area is compact size, bin shelving and gravity flow racks are utilized to facilitate order picking and reduce the fluctuation of order-picking productivity. As a downside the forward-reserve area system is a two-echelon inventory system, thus imbalance of the inventory level between these two areas can lead to a greater variance in throughput. (Gong and de Koster, 2011) This imbalance could be amplified because according to van den Berg and Zijm (1999) in some facilities the forward and reserve areas are further divided into an order-picking and a replenishment area.

Goods can also be organized in the storage into small pick zones, which are usually in close proximity to each other. Pickers can be dedicated to one or more zones to pick the required items. This strategy allows the picker to achieve a high ratio of stock-keeping unit extract time to traveling time between locations and a increased familiarity of SKUs within the zone. It is also possible to arrange different zones according to different storage strategies like random, class-based and dedicated storage. Within different zones or warehouse departments goods are assigned a storage location which has a significant impact on storage capacity, inventory tracking and order picking. (Gu et al., 2007)

Order picking is the costliest function in the warehouse and also the most complex. However it is not the main theme of this thesis so this text will only present some of the problematic of order picking. As with other warehouse activities, order picking strategies are dependent of warehouse design strategies and the activities performed during order picking vary according to the design. De Koster et al. (2007) notes that products are assigned to storage locations according to a storage assignment method, however before such an assignment can be made it has to be decided which picking activities are going to take place in which storage system. According to De Koster et al. (2007) order picking process involves clustering and scheduling the customer orders, assigning stock on locations according to order lines, releasing orders to the floor, picking the articles from storage and disposing the picked articles. Many different order-picking strategies can be applied in warehouses. The strategies are

typically divided to picker-to-parts-systems and parts-to-picker systems. Parts-to-picker systems include automated storage and retrieval systems which can streamline the process, reduce response time and improve service (Gong and de Koster, 2011).

The most common order picking systems are picker-to-parts systems, where the order picker walks or drives along the aisles to pick items. The picker-to-parts systems are further divided into low- and high-level picking according to the height of the storage racks which determines whether the picker needs to use an aiding vehicle during picking or not. (Gong and de Koster, 2011) The basic variants or picker-to-parts systems include picking by article or batch picking and pick by order or discrete picking (De Koster et al., 2007). Discreet picking means picks multiple orders at the same time. De Koster et al. (2007) presents also variants of these systems: sort-while-pick where pickers sort the items immediately after picking and pick-and-sort, where picker sorts the items after the picking process. If the warehouse is divided in zones, wave picking can be used. It is a strategy where orders for a common destination are released simultaneously for picking in multiple warehouse areas. (De Koster et al., 2007) Farahani et al. (2011) points out that this enables controlling the flow of goods and other warehouse processes like replenishment, picking, packing, marshalling and shipping, while the waves are usually tied to the schedules of outgoing vehicles.

De Koster et al. (2007) depicts put systems as an alternative to the traditional order picking strategies. Put systems consist of retrieval and distribution process. First the items are retrieved and then the carrier with these pre-picked units is offered to an order picker who distributes them over customer orders and puts them in customer cartons. These systems are popular in the case where a large number of order lines have to be picked in a short time window. (De Koster et al., 2007)

Recent trends in manufacturing and distribution have made order-picking design and management more complex. Smaller lot sizes, point-of-use delivery, order and product customization, and cycle time reductions have been trending in manufacturing. In distribution logistics companies are providing rapid and timely delivery within tight time windows, which shortens the order-picking time. Postponement strategies allow companies to be more responsive to customers, which leads to various value-adding activities like kitting, labeling, product or order assembly, customized packaging or palletization that take place in the distribution center. These activities have to be scheduled and integrated in the order-picking process. Warehouses also recover products, materials and product carriers from customers in order to redistribute them to other customers, recyclers and original-equipment manufacturers. (De Koster et al., 2007)

If the orders have been picked in batches the picked orders need to be accumulated and sorted into individual customer orders. Usually these processes apply mechanical equipment like conveyors and sorters and the throughput depends on man-machine balance. Inaccuracies can also derive from mechanical errors like faulty sortation. The departure process is affected by such inaccuracies, thus the departure rate can be reduced. These uncertainties can be reduced if the workers check during packing whether the customer orders are complete and accurate. Shipping inaccuracy, e.g. shipping the wrong products to wrong customers is one of the main uncertainties in the shipping process. These uncertainties can further be magnified by errors in electronic messages. Other uncertainties can be wrong order batch or wrong space calculations during shipping container loading or shipment staging like departure rate fluctuations because of human factors. Uncertainties can also be caused by failures of shipping equipment. (Gong and de Koster, 2011)

Global business has created new types of costs to supply chains. According to Choy et al. (2011) cross-border supply chains have become increasingly important for manufacturers seeking lower operational costs. However cross-border trading raises the costs of supply chains. Choy et al. (2011) list a following challenges: trucking from one location to another, handling costs and associated times of inspections for pre-clearance and storage, costs of loading and unloading, drayage costs and times of border crossings and inspections on each side of the borders. The cross-border inspection activities can result in time and cost inefficiencies in order fulfillment so warehouse outbound operations should focus on assisting the planning process with the consideration of cross-border requirements. (Choy et al., 2011) De Koster and Warffemius (2005) suggest that outbound operations should be planned carefully as they affect cross-border operations which follow the outbound process.

2.2.2 Warehouse management

Gong and de Koster (2011) classify decision making in the warehouse into three categories: strategic, tactical and operational. Strategic decisions in warehouses are made on the warehouse automation level, layout and warehousing systems. These decisions have a long-run effect while the tactical decisions have a medium-term effect that is either monthly or quarterly. Tactical decisions are made on storage, order picking and shipping tactical plans. Operational decisions are made on daily basis and include daily order picking planning, resource planning and warehouse information system management. (Gong and de Koster, 2011)

Rouwenhorst et al. (2000) divide the decisions made in the warehouse by processes. The required processes are defined by the process flow design. As described in

the Chapter 2.2.1 the basic process flow includes receiving, storage, order picking and shipment. Rouwenhorst et al. (2000) addresses also additional processes which have an immediate impact on the selection of the technical means and equipment. Sorting process may involve a sorting system and the inclusion of a forward or reserve replenishment system requires the presence of a bulk storage and an order pick area (Rouwenhorst et al., 2000).

Planning the storage process includes deciding the storage policy like a dedicated storage policy, random storage policy, class storage policy (ABC zoning), correlated storage or family grouping. If the storage consists of a reserve storage and a forward storage a reserve storage policy is also needed. Forward, reserve and replenishment strategies decide which articles are stored in the forward area in which quantity and how replenishment is timed. These are also partly design problems. (Rouwenhorst et al., 2000) Gu et al. (2007) simplifies the management of the storage function to three fundamental questions. How much inventory should be kept in the warehouse for each stock keeping unit, how frequently and at what time should it be replenished and where should the SKU be stored in the warehouse and distributed and moved among the storage areas. (Gu et al., 2007) According to van den Berg and Zijm (1999) if sophisticated production planning and ordering policies are applied, the total inventory can be reduced while a satisfactory service level is guaranteed. This specifies the percentage of orders which are supplied directly from stock. If inventory levels are reduced, the inventory costs are reduced and the efficiency of the order-picking in the warehouse is improved. (van den Berg and Zijm, 1999)

As described in Chapter 2.2.2 order picking is a complex process. Usually parts of orders are assigned to one of more order pickers. According to Rouwenhorst et al. (2000) order picking is subjected to various control problems. If a zoning policy is in use the total pick area is divided into picking zones which are served by different order pickers. There are two picking policies: parallel or sequential zoning. Orders can also be picked one by one or in batches. In case of batch picking the picked orders have to be sorted, in which case the sorting policy has to be selected. Then a routing policy has to be selected to define the sequence of retrievals and the route to the retrieval locations. A dwell point policy describes the position of idle order picking equipment. (Rouwenhorst et al., 2000)

If there is a consolidation and sorting process, a sorter lane assignment policy is necessary for allocating orders to output lanes. During the shipping phase orders and trucks need to be allocated to docks by a dock assignment policy. Operator and equipment assignment policies allocate the tasks to personnel and equipment. (Rouwenhorst et al., 2000)

The framework for the control of warehouse processes is defined by the planning policies. Control problems deal with the sequencing of order picking and storage or retrieval policies, while inventory management and storage location assignment policies determine which products arrive and where they will be stored. Inventory management and production planning reduce inventory levels and the operational costs for storage and retrieval and order picking. If smaller ordering quantities need to be delivered frequently, inventory reductions may be established. Nonetheless if all the deliveries occur at the same time, the storage space needed may be considerable. (van den Berg and Zijm, 1999)

Typically a warehouse system suitable for a distribution warehouse is a highly automated but a costly order picking system. This derives from a desired throughput and a required short response time which rules out already a number of technical solutions and indicates the use of more automated systems. A production warehouse is designed to store raw materials, work-in-process and finished products, associated with a manufacturing and/or assembly process. If the procurement batch of incoming parts is much larger than the production batch or the production batch exceeds the customer order quantity of finished products it may be necessary for the raw materials and finished products to be stored for long periods. Therefore storage capacity is the main driver of the warehouse design and the main objectives are low investment and operational costs. The storage has to be designed so that the retrieval from the warehouse is fast and there will not be delays in the production process. This sets design constrains with the response time. (Rouwenhorst et al., 2000)

2.3 WMS

Rouwenhorst et al. (2000) define the warehouse management system as a database driven application used by logistics personnel to improve the efficiency of the warehouse. Warehouse management systems are used to plan, optimize and execute warehouse operations (Autry et al., 2005), manage resources within the warehouse (Choy et al., 2011) and to maintain accurate inventory by recording warehouse transactions (Rouwenhorst et al., 2000). WMS provides real time view on material flows within the warehouse such as tracking and keeping note of the movement and storage of SKUs within a warehouse while it facilitates the optimal use of space, labor and equipment (Choy et al., 2011). Warehouse management systems can be part of an enterprise resource management system (ERP), supply chain execution suite or stand-alone systems (Ramaa et al., 2012).

According to Ramaa et al. (2012) and Faber et al. (2002) literature distinguishes

three types of warehouse management systems: basic, advanced and complex. The basic WMS focuses mainly on throughput and the information is simple. The system supports only stock and location control. It determines the location where the received goods are stored and registers this information, generates stocking and picking instructions which can possibly be displayed on radio frequency terminals. Advanced warehouse management systems adds on top of this functionality the ability to plan resources and activities and synchronise the flow of goods in the warehouse. This type WMS focuses on throughput, stock and capacity analysis. The complex warehouse management system enables the optimization of the warehouse or several warehouses. It provides information about where each product is, where it is going and why. It uses complex storage, replenishment, cycle counting and picking strategies and is able to interface with advanced warehouse technology. It also offers additional functionality like transportation, dock door and value added logistics planning and also simulation to optimize the parameter setting of the system and the warehouse operations as a whole. (Faber et al., 2002; Ramaa et al., 2012)

2.3.1 IT in warehouse operations

Gu et al. (2007) states that the implementation of new information technologies provides new opportunities to improve warehouse operations. These technologies include bar coding, radio frequency communications (RF) and WMS (Gu et al., 2007). According to Ramaa et al. (2012) WMS systems can be stand-alone modules or part of enterprise resource planning or ERP systems. van den Berg and Zijm (1999) notes that ERP systems often supports functions like warehouse management, transportation planning, production scheduling and order entry and processing but for more complex operations specialized systems like warehouse and inventory management systems are used. These systems are linked together using electronic data interchange (EDI) (van den Berg and Zijm, 1999). The warehouse management system can be deployed as paper-based, RF and wireless-based or combination of both (Ramaa et al., 2012).

De Koster and Warffemius (2005) emphasizes that information technology is an important factor for connectivity and transparency in the supply chain. This includes the use of barcodes, warehouse management systems, to internet trading and electronic data interchange with suppliers. Information in the supply chain has partly substituted the physical inventory and continues to do so. (De Koster and Warffemius, 2005) Luisa dos Santos Vieira et al. (2013) adds that information technology plays a critical part in supporting outsourcing arrangements thus it is critical for logistics service providers. To improve logistics performance LSP have increased

the use of IT to become more efficient and have begun offering logistics services with added value. The technologies that have enabled this are warehouse management systems, transport management systems (TMS), track and trace systems (TTS), routing systems, radio frequency identification (RFID), barcode, EDI and the internet. (Luisa dos Santos Vieira et al., 2013)

De Koster and Warffemius (2005) measures the degree of automation in the warehouse through a five-point scale: very low, low, average, high and very high. Very low degree includes only basic automation, low means that a WMS is used, average adds bar-coding on top of using WMS and high degree of automation includes WMS, bar-coding and wireless communication. Very high automation level includes all of the before mentioned technologies with other systems like EDI, sorters, automatic storage and retrieval systems, carousels, automatic guided vehicles and packaging machines. (De Koster and Warffemius, 2005)

2.3.2 WMS functionality

Faber et al. (2002) classify the functionality of the warehouse management system into three categories: warehouse execution control functions, inter-warehouse management functions and warehouse management functions.

Inter-warehouse management functions include enterprise definition, inventory analysis, replenishment management and tracing. Enterprise definition is the functionality which specifies the bill of distribution and the clustering of warehouses. (Faber et al., 2002) The bill of distribution determines the supply channel structure that is the linkages and dependencies between the multiple entities constituting the supply network (Ross, 2015). Inventory analysis provides information about the inventory of a product or a group of products in the different warehouses. Replenishment management controls the inventory assortment spread on basis of expected demand and supports the strategy to replenish warehouses, which may take place from a central warehouse, production centers or suppliers. Tracing enambles management to follow the flow of specific goods and orders. (Faber et al., 2002)

Warehouse management functions include warehousing organization definition, resources and activities planning, inventory control on location and management information. Warehouse organization definition specifies the different zones and storage areas including information like dimensions, storage rules, picking strategies and storage conditions. Resources and activities planning ensure that tasks are performed as efficiently as possible by matching available resources with receiving, shipping, transferring, loading, unloading, cycle counting, and assembling activities.

(Faber et al., 2002) Inventory control includes activities that coordinate purchasing, manufacturing, and distribution for maximizing the availability of raw materials for manufacturing or the availability of finished goods for customers (Farahani et al., 2011). Inventory control on location is based on aggregated data from execution reports in relation to inventory levels. This allows identifying low demands, excess stock, inactive, blocked and obsolete products. (Faber et al., 2002)

Management information concerns the reporting in the warehouses. Reporting can be divided into three categories: daily progress monitoring, performance overviews and reports concerning long term efficiency. Daily progress monitoring includes bottlenecks and which orders are not in schedule. (Faber et al., 2002) According to Faber et al. (2002) performance overviews include for example the number of orderlines processed during certain period and number of receipts handled. Reports concerning long term efficiency include overviews of misplaced articles, rack occupation and articles with problems. (Faber et al., 2002) Min (2006) adds that the goal of performance reporting is to produce performance measurements against established standards for space utilization, order fulfillment, total throughput and loss/damage, while creating an audit trails for warehousing activities.

Warehouse execution control includes all the functions that are related to the cycle of operational planning, execution and control. In other words, in order to enable the flow of products through the warehouse, employees need to know what to do, when to do it, and how to make sure the work is done properly. This includes yard management, receiving, inspection of the quality of goods, stock movement, location control, inventory control, warehouse service activities, packaging and packing, shipping, transport and distribution, internal replenishment, cycle counting and customs management. (Faber et al., 2002)

Receiving generates information to plan, execute and control all operations from the moment goods are announced as shipment to the warehouse receiving dock to verification with the original customer purchase order. This includes goods to be received from suppliers, production or other warehouses and also customer return goods. (Faber et al., 2002) First step in the warehouse material flow is the delivery notification after the goods have been ordered by the company's dispatcher. Usually the delivery notification includes a precise delivery date. This is necessary especially when there is a high number of deliveries and a low goods reception capacity. After this the goods acceptance process begins. The consignment is compared with the purchase order and the bill of lading is compared with the delivery notification. The notification data is then entered into the inventory system temporarily. At this stage the goods receipt department can be informed about the pending delivery.

(Ten Hompel and Schmidt, 2007)

The purpose of yard management is to generate information for planning and controlling the use of receiving and shipping docks (Faber et al., 2002). In larger warehouse systems the goods acceptance and goods receipt areas are usually separated so the arriving trucks have to be directed and assigned to the loading gates. This enables a better yard traffic control. (Ten Hompel and Schmidt, 2007)

Inspection of the quality of goods can be performed during receiving, shipping or during a periodical inventory check. It can be initiated from item or supplier specification and includes also the initiation and managing of testing activities. After inspecting the goods the approval process determines what to do with them: accept, reject, scrapping or re-work. (Faber et al., 2002) Ten Hompel and Schmidt (2007) notes that during goods acceptance all goods are inspected with regard to type and quantity by the unloading staff but the quality assurance is usually performed only for some goods according to the company rules.

The purpose of the stock movement function is to generate information for executing and controlling all the movements of goods within the warehouse. It includes put-away, picking and internal transfer processes including cross-docking which are based on warehouse orders. These can be grouped in picking and put-away runs. Location control determines and registers the storage location of goods based on storage strategies. Inventory control generates information to monitor stock levels, flows of products, and the status of orders. Warehouse service activities is a function that can be applied during inbound, storage and outbound. It generates information to plan, execute and control service activities requested by the customer like assembly and other value-added services. (Faber et al., 2002)

According to Faber et al. (2002) packaging and packing function controls information for repackaging goods into handling units with the same unit of measure or to group items. Ten Hompel and Schmidt (2007) points out that in many warehouse and material flow systems special loading aids are used for security reasons. These can be tray storage or rack systems with standardized containers. Incoming are usually consolidated into volume and quantity-optimized units so that the shipping and transport costs have to be minimized but in the warehouse goods are refilled in company-specific containers and consumption units to fit the material flow system. (Ten Hompel and Schmidt, 2007)

Shipping function generates information to control the organization of loads. This includes preparing shipping documents like bill of loading and customs clearance. Transport and distribution function optimizes transport and distribution processes

like truck loading and vehicle routing. Internal replenishment handles the information to control pick stock. If the stock falls under a certain predetermined level a replenishment order will be generated to replenish the pick stock from the bulk storage. Cycle counting supports the checking of the physical inventory where the actual stock level is registered, analyzed and validated. Finally, customs management supports all customs and taxes-related activities that are connected directly to physical operations. This includes for example the administration of single administrative documents or SADs, custom status of products on location and country of origin codes. (Faber et al., 2002)

Outsourcing leads to new requirements for warehouse management systems in addition to the basic functionality. Figure 2.4 presents how the basic elements of warehouse management systems relate to the warehouse operations according to Ten Hompel and Schmidt (2007). Ten Hompel and Schmidt (2007) explains that outsourcing can mean that a licensed logistics provider can take over and operate an existing warehouse, or the stocks can be transferred to an external warehouse of the LSP where they are stored together with the stocks of other companies, which means the warehouse is a multi-client system. Since warehouse serviced are usually paid based on performed transactions it is necessary to make the activities measurable and transparent. In multi-client systems for example goods of apparent same value are subjected to different processes during stock-taking. Thus the warehouse management systems implemented have to be highly transparent, general purpose systems which meet different requirements depending on their application. Adjusting the processes in multi-client environment also means that it is necessary to consider not only the goods and customers but also the client. Thus the WMS has to be multi-client enabled. Since the billing is based on the performed activities single client-related services like stacker trips and picking positions have to be recorded separately. (Ten Hompel and Schmidt, 2007)

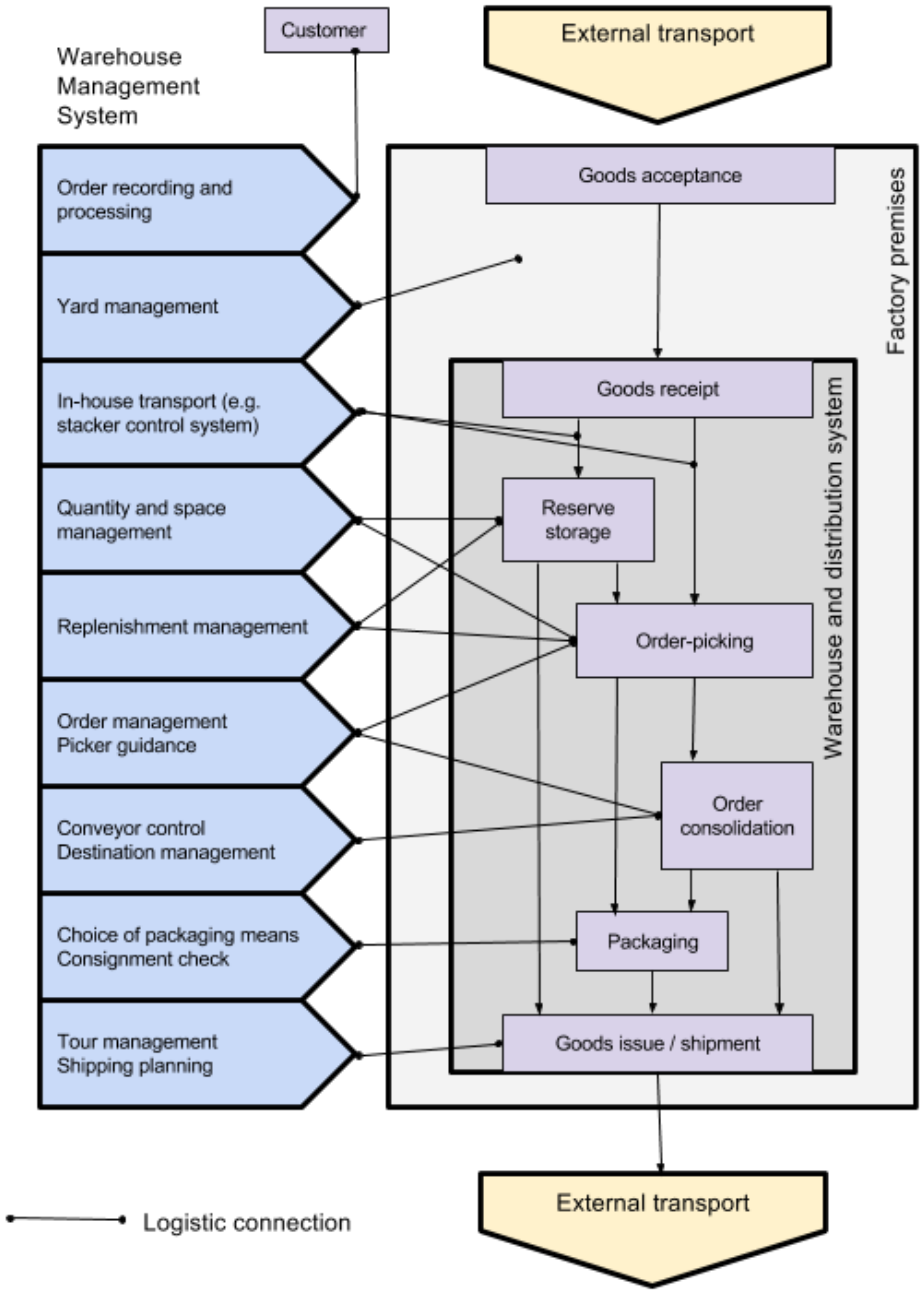

Figure 2.4: Basic elements of warehouse management systems and their role in regard to warehouse operations, adapted from Ten Hompel and Schmidt (2007).

2.3.3 WMS benefits

According to Ross (2010) WMS software solutions were introduced in the late 1970s and nowadays form a billion-dollar market. During that time they evolved from simple shipping and inventory functions to today's robust systems (Ross, 2010). To maintain high performance in warehouse operations means it is necessary to implement a planning and control system that provides timely and accurate information about products, resources and processes. The flow of products within a warehouse is managed by a warehouse management system that provides, stores, and reports the necessary information from the receipt of goods to time of shipping. (Faber et al., 2002) The necessity of using a WMS is highlighted in several sources (Manzini, 2011; Ramaa et al., 2012; Faber et al., 2002). According to Ramaa et al. (2012) implementation of a WMS will increase accuracy, reduce cycle times which leads to a greater ability to serve the customer and reduce labor costs if the labor employed to maintain the system is less than the labor saved on the warehouse floor. In addition to reducing the need for inventory it also leads to a greater storage capacity by optimizing the space used for storage. Reductions in the required safety stock are possible because the WMS increases accuracy and efficiency of the receiving process. (Ramaa et al., 2012) In the research of Davarzani and Norrman (2015) reducing discrepancies by providing accurate information on inventory and storage location was seen as the main benefit of using WMS. The evolution of e-commerce was considered as a factor that compels organizations to make critical changes to warehouse operations, strategies and requisite IT systems like WMS (Davarzani and Norrman, 2015).

Ramaa et al. (2012) describes that complexity in warehouse management is indicated in heterogeneity of handled products, the extent of overlap between them, amount of goods handled, type of technology used in handling the goods as well as characteristics of associated processes. Warehouse management systems are necessary for handling warehouse resources and monitoring warehouse operations when complexity increases (Ramaa et al., 2012) The tasks that WMS has to take on are for example finding the best location where an incoming load can be stored, the best location from which an order line can be picked, the right person to pick an order line in the right sequence while minimizing travel time and the regular update of article-to-location assignments to internally move products to make sure that articles are cycle counted regularly without disturbing the main work flows. Pick-to-light and put-to-light systems and use of right communication means with drivers and pickers are tools that can be used to speed up processes and reduce errors. (Manzini, 2011)

Ramaa et al. (2012) argues that customized warehouse management systems support warehouses with high amount of processed order lines and stock keeping units. This is because in bar-code-based or manual-based warehouse systems it is difficult to update daily operations of inventory level, locations of forklifts and stock keeping units (SKUs) in real time (Ramaa et al., 2012). WMS systems provide a real time view into material flows in the warehouse by tracking and keeping note of the movement and storage of material within warehouse while optimizing the use of space, labor and equipment. For the managers it enables to optimize transactions to and from warehouse operators, recognize problem areas and shifts in activity levels and patterns. At the same time it also makes it possible to continuously determine performance indicators such as productivity, shipping and inventory accuracy, warehouse order cycle time and storage density. Typical WMS systems are also connected to material handling automation and transportation information systems. (Helo and Szekely, 2005)

2.3.4 IT capabilities in warehousing

Murphy and Wood (2004) define logistics information systems or LIS as people, equipment, and procedures used to gather, sort, analyze, evaluate, and distribute needed, timely and accurate information to decision makers. Warehouse management system is one of these LIS designed and implemented for strategic purposes. Autry et al. (2005) state that these systems aid significantly in decision making related to the planning, assessment and control of logistics activities.

Resource-based theory addresses company resources as assets, capabilities, processes and information that enable the company to implement strategies that improve its efficiency and effectiveness. Technological resources alone are insufficient to allow firms to gain competitive edge through resource inequalities over long periods of time, but interweaving technological resources to existing business processes provide a basis for developing capabilities that can be used to develop the long-term performance of the company. (Autry et al., 2005) Advanced IT contributes to enhanced performance benefits by facilitating integrative operations in supply chains. Decision support applications like warehouse management systems relate to a company's supply chain IT analytic capability. From resource-based perspective this capability contributes to competitive advantage and facilitates a range of supply chain activities. At short-range operational level this capability assists for example in setting daily retail inventory levels and optimizing delivery schedules. In medium-term managerial decisions it enables efficient deployment of transportation capacities and product allocation decisions for manufacturing facilities. At the strategic level

the capability provides clear and summarized information for configuring the supply chain network and adding manufacturing or warehousing facilities. (Iyer, 2011)

2.4 Contract logistics

According to Taylor (2007) outsourcing is a practice where two companies bring their core compentencies together, which creates opportunities for positive synergy. It is an agreement between a business and a third-party provider for ongoing management and improvement activities related to a business function (Taylor, 2007) Logistics outsourcing has its roots in the 1950's and 1960's. The trend began with outsourcing transportation and warehousing and later evolved into a supply chain optimization trend where the outsourcing relationships were long lasting. The range of services offered has increased from single part of the supply chain like warehousing to controlling the whole supply chain. (Farahani et al., 2011)

The use of external companies to perform logistics functions is called third party logistics or 3PL. Companies which offer 3PL services can be called logistics service providers (Waters 2003). Third party logistics means that the contractor provides services directly to the outsourcing company. In more complex supply chains there might be a fourth party acting between the logistics service providers and the outsiders, which is called fourth party logistics or 4PL (Taylor, 2007).

The range of the term 3PL vary in the literature from providing more traditional outsourced logistics functions to controlling the customer's whole supply chain (Farahani et al., 2011; Ross, 2010; Baudin, 2004; Marasco, 2008; Waters, 2003). According to Baudin (2004) the companies which acknowledge themselves as 3PL providers offer a varied range of services starting from transportation and logistics extending to warehousing and even further to comprehensive supply chain solutions. Farahani et al. (2011) separate the traditional logistics service providers and 3PL providers by defining that 3PL provides of broader range of services, a long-term duration, the customization of the logistics function and a fair sharing of benefits and risks. In addition to the basic logistics services the third party logistics service providers now offer functionality in finance, inventory, technology and data management (Ross, 2010). Farahani et al. (2011) describe this change as a gradual shift from asset based players to skill or systems based players.

Third party logistics service providers usually offer activities like transportation, warehousing, inventory control, distribution and materials procurement. An example of outsourcing a single process could be warehousing, where the service provider owns the warehouse, conducts the warehousing operations and controls the processes

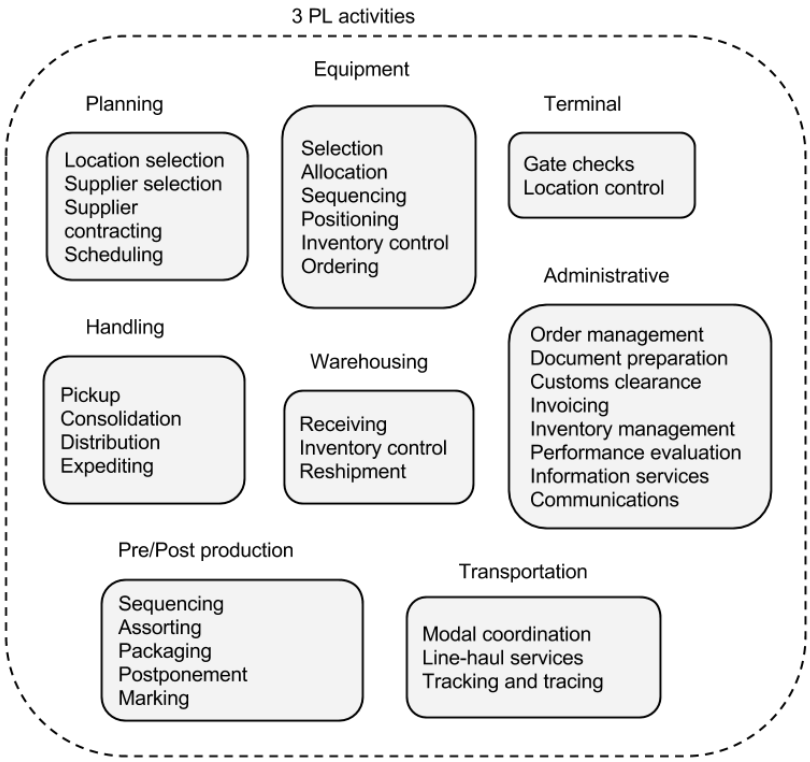

Figure 2.5: Third party logistics activities, adapted from Farahani et al. (2011).

like order picking, assembly and cross-docking. (Taylor, 2007) Farahani et al. (2011) presents a comprehensive list of third party logistics activities which is presented in Figure 2.5.

Third party logistics service providers can be divided into four different categories: standard 3PL providers, service developers, customer adapters and customer developers. The first category companies offer the most basic functions like picking and packing, warehousing and distribution. Service developers include also value-added services such as tracking and tracing, cross docking, specific packaging and providing a unique security system. Customer adapters provide all the services customers request and take control of the customers' logistics activities. The highest level of providers is customer developers, which take over the entire logistics function of the customer and perform extensive tasks for the customer. (Farahani et al., 2011)

According to Waters (2003) the most common reasons for logistics outsourcing are improving service, reducing costs, increasing flexibility and avoiding investments. Other reasons were outsourcing a non-core activity, obtaining specialist management and improving control (Waters, 2003). Marasco (2008) describes three factors driving logistics outsourcing: network complexity, process complexity and product complexity. The company is likely to seek out third party logistics service providers

to handle its supply chain processes if the supply chain network is dispersed geographically or if the logistics process is complex in terms of time and task. Also in the case of products and materials which need a special environment in terms of for example humidity and temperature it is likely that the company will outsource its supply chain processes to a third party service provider (Marasco, 2008). Taylor (2007) notes that outsourcing is often a part of a business re-engineering process and should therefore not be treated as a stand-alone function.

Farahani et al. (2011) lists the benefits of outsourcing logistics as following: the organization will be led to save time, share responsibility, re-engineer distribution networks, focus on core competencies, exploit external logistical expertise, reduction in inventory levels, order cycle and lead times, economies of scale and scope and improved efficiency, service and flexibility. However it is important to note that if the cooperation with the service provider does not succeed it can lead to poor coordinating efforts and information sharing, loss of control and poor service performance (Farahani et al., 2011). According to De Koster and Warffemius (2005) 75 percent of the partnerships between shippers and logistics service providers is formalized by a written contract, of which 40 percent include a penalty clause for providers if they do not meet the agreed performance targets. However 50 per cent of the contracts do not specify activities and performance targets in detail which indicates that LSPs often have flexibility and can use creativity in shaping the logistics activities they carry out (De Koster and Warffemius, 2005).

Rahman (2011) claims the users of 3PL typically use an extensive range of services. The most frequently used functions are warehouse management (64 percent), order fulfillment (59 percent), fleet management (41 percent), product returns (27 percent), shipment consolidation (27 percent) and order processing. For example in Australia studies show that using warehouse services are in rapid rise. 3PL providers are expanding their offering from classical warehousing functions such as storage to include cross-docking, product returns and value-adding services. (Rahman, 2011) Rahman (2011) also argues there is evidence that outsourced warehouse services provide the greatest cost benefits out of all 3PL services.

At present businesses are emphasizing the needs of individual customers which has led to postponement strategies being used more. Postponement leads specifically to savings in inventory, transportation and reduced inventories of obsolete products. Borders between warehousing, assembly and retail operations are disappearing and the warehouse has became the place for final assembly, blending, labeling and packaging in addition to storage. This allows closeness to markets, low labor costs and effective systems for operations mentioned earlier. (Zakery, 2011) Having customers

who expect more means that logistics service providers need to design customized services that require proper planning and strategy development (Davarzani and Norrman, 2015). To survive in the changing environment the logistics service providers need to develop strategies to benefit from the new opportunities and to meet the customer's needs in new situations (Zakery, 2011).

2.4.1 IT capabilities of logistics service providers

Power et al. (2007) suggests that the 3PL industry is maturing because of increased demand worldwide in outsourcing of logistics activities. There is an increased demand of volume and variety of services, which has led to development of different business models in the 3PL sector. According to research there is a significant association between 3PL's competitive priorities, service offerings and the use of technologies to the contribution of the 3PL to customer performance. The competitive priorities are lower cost, higher quality, higher variety, more responsive, more flexible, highly secure, more innovative, packaged solutions, customized solutions and total solutions. Service offerings include among others logistics information and IT solutions. (Power et al., 2007)

One strategy to differentiate in a highly competitive market is to hire a specialized logistics service provider to gain access to modern ICT and supply management tools. Logistics service providers offer their client integrated logistics solutions where IT plays a critical supporting role. The use of information technology has especially increased efficiency in value added services. (Luisa dos Santos Vieira et al., 2013) The use of following technologies has been identified to the contribution of the 3PL to customer performance: advance shipment notification (ASN), automated storage and retrieval systems (AS/RS), electronic data interchange (EDI), XML/EDI, barcoding, RFID, voice input services, portal technologies, the internet, RF communications, enterprise application integration (EAI), electronic marketplaces, extranets, intranets, satellite communication technology, decision support system (DSS) and warehouse management systems (WMS). (Power et al., 2007)

Luisa dos Santos Vieira et al. (2013) states that the logistics services industry has historically been one of the largest investors in IT. Studies show that information technology is a critical and factor to LSP performance and competitiveness (Luisa dos Santos Vieira et al., 2013; Wong and Karia, 2010) According to Wong and Karia (2010) LSPs are continuously developing their firm-specific information systems to improve the following capabilities: providing information for customers to track and trace shipments, automating processes like invoicing, custom documentation and reporting and integration with customers' information systems. Track and trace

ability is considered as a basic and the most important requirement in logistics contracts (Wong and Karia, 2010; Luisa dos Santos Vieira et al., 2013; Liu and Lyons, 2011) but the ability to link information resources with other parties is regarded as a rare competence (Wong and Karia, 2010). Integrating the information systems' capabilities with internal and external processes is also seen more useful than trying to conceptualize information resources in the contracts (Wong and Karia, 2010). Jeffers (2010) argues that in supply chain relationships information itself possesses significant strategic value. The logistics industry is dependent on coordination and timeliness and one of the principles nowadays is to replace inventory with information. As such visibility and transparency are important strategic capabilities which can be achieved quite easily. (Jeffers, 2010)

IT also enables and promotes collaboration, which is considered as a core capability in the supply chain. Logistics service providers seek to make long-term contracts, which means building working relationships with key suppliers and customers. (Wong and Karia, 2010) The findings of Iyer (2011) suggest that IT analytic capability has a significant influence on downstream collaborative behaviors. Demand chain collaboration associates significantly with operational performance (Iyer, 2011). Benefits of using advanced information technology in LSP operations also include greater flexibility, increased productivity, service level increases, better resource management, lead-time reduction, and reductions in administration, raw material, inventory and transactional costs (Luisa dos Santos Vieira et al., 2013).

Information technology capabilities have also been linked to financial performance. Research has shown that in China a greater IT uptake can offer 3PL companies better financial performance (Wang et al., 2008). Liu and Lyons (2011) argues that information systems related capabilities enhance 3PL logistics performance thus indirectly impacts on financial performance. Research by Lai et al. (2007) also shows a higher financial performance in 3PL companies maintaining a higher level of IT alignment with their business strategies.

3. DESIGN AND IMPLEMENTATION OF THE STUDY

This chapter contains a description of the case company, how the study was constructed and the implementation of the study. In the final section the criteria for the actual end product of the study, the warehouse management systems recommendation, is explained.

3.1 The case company

The case company is a logistics operator which offers customized logistics solutions for industry and trade. These include complex service packages and door-to-door solutions covering the entire value chain. The range of services covers all stages in the value chain from procurement, production and distribution logistics to aftersales service. The company has industry expertise in several market segments like automotive, consumer goods and high-tech industries. The services include a number of integrated industry solutions in different market segments.

The company comprises of seven business units and has warehouses in several locations. The company serves customers in several different industries. For the purposes of this study the customers were divided in four classes: automotive, consumer/FMCG, high-tech and industrial. Currently there are several different warehouse management systems in use in the company.

For automotive industries the company offers services like JIT/JIS production supply, SKD, CKD, aftermarket logistics and yard management services.

The warehousing environment in the case company comprises of single warehouse systems and multi-warehouse systems. The business units have both dedicated customer warehouses and multi-customer warehouses. Warehouse sizes vary in business units from small to medium and all the business units in the study manage multiple warehouses.

The case study includes four of the seven business units in the company. Table 3.1

shows the sizes of the participating business units.

Business unit	Total size of warehouses (sqm)	Number of locations
1	268000	10
2	22000	1
3	5000	1
4	65000	7

Table 3.1: Summary of the business units participating in the case study.

3.2 Construction of the study

This study was executed as a part of the company's WMS project. The study was designed in cooperation with the project participants. The main participators in the project were Company Director Logistics and Company Chief Information Officer.

The material consisted of

- two surveys for the business unit logistics managers
- semi-structured interviews with the business unit logistics managers
- informal discussions with business unit logistics and IT representatives
- informal discussions with company internal WMS experts
- previous WMS study material from the company's internal study in the year 2003
- internal material including process descriptions, company history information and industry research made by the company in the recent years.

The study was realized as two surveys send to the company business units. The purpose of the first survey of the study was to find out the general needs of the current and future business for the warehouse management system. The second survey addressed the needs arising from internal operations and different customer types. In addition to the survey data the business unit logistics directors were interviewed using the survey answers as a basis for the discussion topics. The project included also informal discussions in the form of meetings and email exchange with the business unit IT and logistics representatives.

The surveys were based on a WMS study material from the year 2003 which provided the basic structure for the surveys. The previous WMS study material included

a comprehensive list of WMS features which are present in the current extended warehouse management systems. The feature list was extensive and it was separated into two different surveys so that the survey respondents would have more time to concentrate on single questions. Some features were removed from the original list and new features were added as the logistics service trends change during the years and new technology emerges. The company logistics director and the company CIO reviewed the surveys several times. The general warehouse survey was selected as the first survey to be sent to the business units being a more familiar topic to the respondents.

The surveys were constructed as following: for every WMS feature the questions were "Is this in use in the current WMS?" and "Is this needed?". The features were divided in categories according to the functions they were connected to. Both of the surveys included directions on how to answer the surveys. The topics of the first survey were the basic warehouse operations: inbound, outbound, return and inventory. The survey is presented in Appendix A. The questionnaire included internally constructed process descriptions as an example and a support for considering the WMS functionalities needed in the basic processes. The questions included a list of the WMS features and yes/no answer possibility. The purpose of the feature list was to find out which features were in use in the current WMS and which features would be needed in the new system.

The second survey followed the structure of the first survey. The survey is presented in Appendix B. In addition to the yes/no questions it also included open questions which gave the respondents the possibility of further clarifying specific business needs. The questionnaire was divided in two parts: customer needs and internal needs. Customer needs were further divided into four different business classes: automotive, consumer/FMCG, high-tech and industrial. The internal needs part had the purpose of describing what kind of WMS functionality would be necessary to develop internal operations.

The interviews were conducted as open interviews in discussion style, both group and individual interviews depending on the persons available for an interview. Business unit 4 did not participate in the second questionnaire which was more extensive and the schedule did not enable an interview to take place with the business unit 4's representatives. The interviewee from business unit 1 was the logistics director, business unit 2 included the logistics director and IT representative and business unit 3 the logistics director and IT representative. There were also informal discussions in the form of meetings and e-mail exchange during the process with both logistics and IT representatives from business units.

3.3 Implementation of the study

The general warehouse survey was sent to seven business units. From the business units four sent their answer back. After this a second questionnaire was sent to the countries. This questionnaire was sent to the business units that had participated in the first questionnaire and answers were received from three of the business units.

During the time frame given to answer the survey the business unit representatives were encouraged to contact the researcher and ask questions about the surveys. When the answers were sent back, the researcher was given time to process the answers. The open interviews were executed during three next weeks after receiving the answers from each business unit. After the final interviews and discussions the complete case study material was organized and analyzed.

Originally the WMS functionality which was included in the questionnaires was organized according to a more specific WMS function. For analyzing purposes the functions were further sorted into 11 categories using the theoretical part of the study as a basis for the classification. Figure 3.1 presents this classification of WMS functionalities which was used in the analysis of the case study results.

The categories included are:

1. order processing
2. receiving
3. put-away
4. storage management
5. order picking
6. value added logistics (VAL)
7. packing/shipping
8. stocktaking
9. planning
10. third-party logistics (3PL)
11. basic data

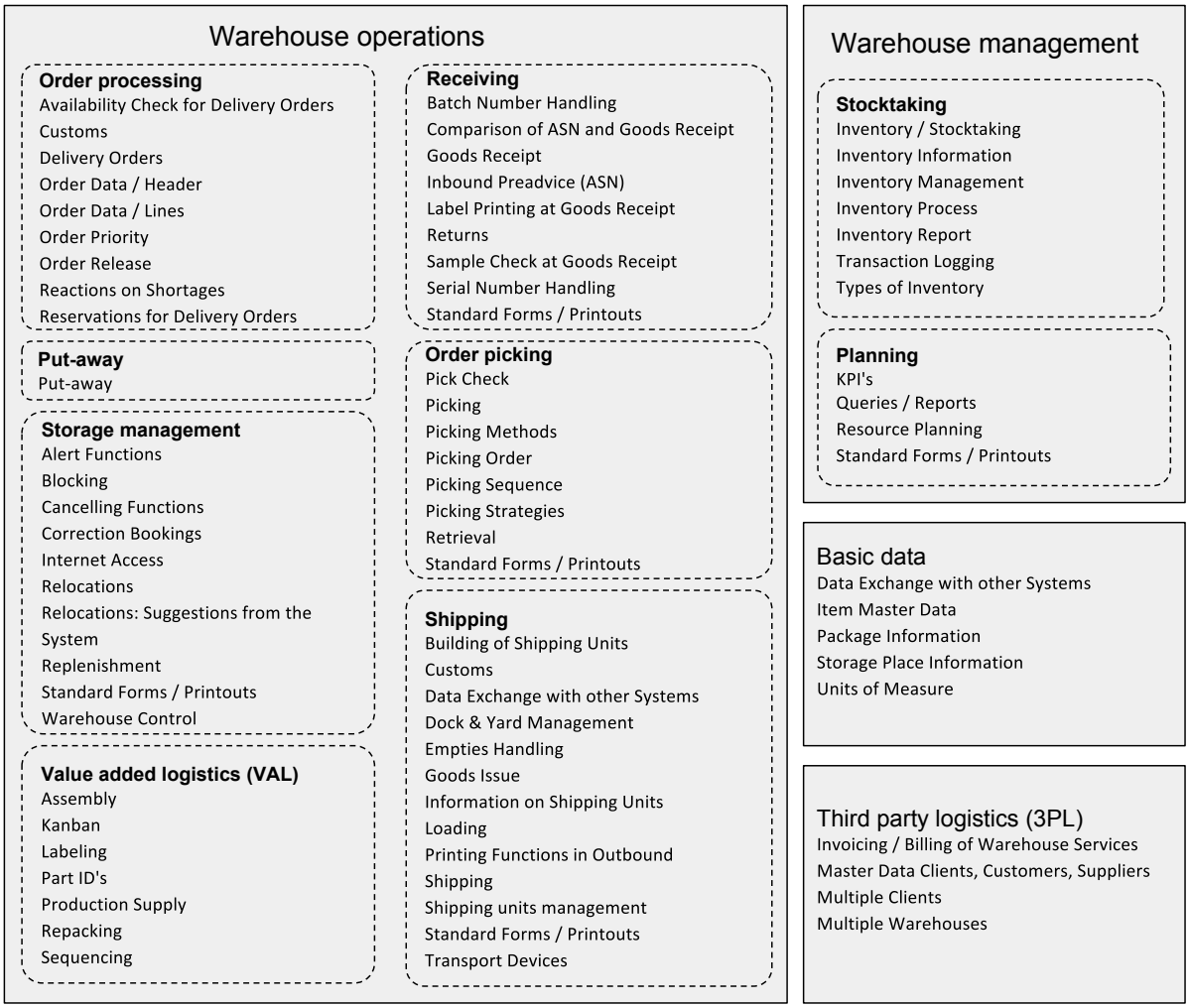

Figure 3.1: The classification of WMS functionalities which was used in the survey data analysis

The categories 1-7 include the following warehouse operations: order processing, receiving, put-away, storage management, order picking, value added logistics, and packing/shipping. The next categories include warehouse management functions: stocktaking and planning. Third-party logistics functions are sorted into one category and all the basic data needed in the WMS is the last category. Table 3.2 shows how much features different categories included in both of the surveys.

Category	General warehouse survey (n)	Internal and customer survey (n)
3PL services	18	27
Basic data	48	16
Order picking	26	10
Order processing	42	12
Packing /Shipping	33	46
Planning	67	2
Put-away	14	12
Receiving	68	12
Stocktaking	53	12
Storage management	43	14
VAL	18	34

Table 3.2: The amount of WMS features included in the surveys by category.

3.4 Criteria for the WMS recommendation

The recommendation is used in identifying the software package which has the best fit for the case company. The final evaluation criteria for compiling the list of functionality needed in the future WMS was discussed during the design of the questionnaires with the persons taking part in the questionnaire design. After the surveys and a preliminary overview of the results were completed the criteria was discussed again with the participants and a final scoring system was determined.

The evaluation criteria was based on the feature lists used in the internal needs questionnaires. The WMS features are divided in six categories: general, internal, automotive, consumer/FMCG, high-tech and industrial. All of the features in the categories are divided in three priority rankings: A, B and C. Ranking "A" means that the feature has been considered as needed in three or more questionnaire answers. Features with two "needed" answers are in the B category and features considered needed by only one respondent are in the C category. Features that were regarded as nice to have were not taken into the final recommendation.

4. RESULTS

In this chapter the results of the study are presented. Section 4.1 presents an overview of the results for the case company as a whole and section 4.2 presents the business unit specific results in more detail. Section 4.3 compares the results with literature. Finally, in the section 4.4 a recommendation for the functionality of a suitable warehouse management system is presented.

4.1 The case company

4.1.1 General warehouse survey

The survey included 430 features that were considered vital for basic warehouse processes. Every feature in the survey was needed at least in one of the business units. Out of all features 157 or 36 percent were needed in all of the business units. In addition 57 percent of the features were considered needed in 2 or more business units.

The needed functionality varied between business units from 39,3 percent to 100 percent as can be seen in Table 4.1. The coverage of current general warehouse functionality in use varies widely between business units, from 24 percent to 67 percent of the features included in the survey. 89 percent of the features were in use in one or more business units.

Business unit	Needed (%)	Not needed (%)	In use (%)
1	100	0	66,7
2	50,5	49,5	49,3
3	39,3	60,7	24,4
4	54,2	45,8	39,8

Table 4.1: General warehouse features needed, not needed and in use in the business units.

Business unit 1 is the largest of the business units participating in the case study and has the widest needs in the general warehouse section. The amount of needed features roughly follow the size of the business units. Unlike the other business units that need a lot more features than are in use in their current WMS, business unit 2 need just 1,2 percent more features in the new system. All the features in use in the current system are needed so it suggests that the current WMS in business unit 2 is fulfilling at least the general warehouse needs.

Category	All business units (%)	Two or three business units (%)	Not needed (%)	In use in one or more units (%)
3PL services	55,7	38,9	0	100
Basic data	60,4	33,3	0	95,8
Order picking	11,5	73,1	0	92,3
Order processing	52,3	38,1	0	90,5
Packing /Shipping	27,3	60,6	0	93,9
Planning	32,8	67,2	0	74,6
Put-away	14,3	85,7	0	100
Receiving	41,2	51,5	0	97,1
Stocktaking	43,4	49,1	0	92,5
Storage management	18,6	76,7	0	93,0
VAL	5,6	94,4	0	44,4

Table 4.2: The division of general warehouse features needed in the business units and in use in one or more of the business units.

Table 4.2 describes how the WMS features in different categories were divided. In the categories basic data, 3rd party logistics services and order processing over 50 percent of the features were needed in all of the business units. The next important categories were stocktaking, planning and packing/shipping varying from 27,3 percent to 43,4 percent. Interestingly the categories where every feature was needed in two or more business units were planning, put-away and value added logistics. In other categories the amount of features needed in two or more business units go from 84,6 percent upwards. Hence it can be said that there are few features that are needed only in one business unit which means that most of the features included in general warehouse survey will be included in the final system recommendation.

In most of the categories over 90 percent of the features were in use in one or more business units. Only planning and value added logistics stay under 90 percent with planning at 74,6 percent and VAL with 44,4 percent. This indicates that the functionalities in the current warehouse management systems vary greatly, however a multitude of the features are not needed everywhere.

4.1.2 Internal and customer needs survey

The internal and customer type specific needs survey answers varied greatly. Only three business units submitted their answers to the questionnaire. The survey included a total of 197 WMS features.

In the internal needs part 19 of the 197 features were considered needed in all of the business units. 119 features were needed in two of the three business units and only 10 features were considered not needed in any of the business units. 131 features were in use in internal operations in one or more of the business units. Table 4.3 presents the distribution of the answers in detail.

Needed in all business units (%)	Needed in 2 business units (%)	Needed in 1 business unit (%)	Not needed (%)	In use in 1 or more business units (%)
9,6	60,4	24,3	5,1	66,5

Table 4.3: The distribution of answers in the internal needs survey.

The answers of the business units were divided as Table 4.4 shows. Here, business unit 1 is the largest with 88,3 percent of features being needed in internal operations and business unit 2 is the second largest with 76,1 percent of features needed. In business unit 3 only 0,5 percent of features are needed. Business unit 2 has more features currently in use than business unit 1 while business unit 3 has none of the features in use.

Business unit	Needed (%)	Not needed (%)	Nice to have (%)	In use (%)
1	88,3	12,7	11,7	43,2
2	76,1	23,9	8,6	44,2
3	0,5	99,5	0	0

Table 4.4: Features needed, not needed, nice to have and in use in the business units in internal operations.

Table 4.5 describes how the WMS features were divided in different categories. Only the categories 3PL services, order picking, packing and shipping, receiving, stocktaking and storage management included 100 percent needed features. Order picking had proportionally the most features with 40 percent of the features being needed in all business units. 3rd party logistics services was the second largest category with 29,6 percent and third largest category was storage management. Other categories included under 10 percent of the features in the survey. Features needed in two business units vary between categories from 30 to 83,3 percent except for planning category which has none. All other features are needed at least in one of the business units except 12,5 percent of features in the category basic data, 10,9 percent in packing and shipping, 50 percent in planning, 8,3 percent in stocktaking and 2,9 percent in value added logistics. 100 percent of the 3rd party logistics features are currently in use while none of the planning features are in use. 5 out of 11 categories have over 80 percent of the features included in the survey in use. The least features in use are in planning (0 percent) and packing and shipping (41,3 percent).

Category	Needed in all business units (%)	Needed in 2 business units (%)	Not needed (%)	In use in 1 or more business units (%)
3PL services	29,6	59,3	0	100
Basic data	0	68,8	12,5	81,3
Order picking	40,0	30,0	0	70
Order processing	0	83,3	0	83,3
Packing /Shipping	6,5	52,2	10,9	41,3
Planning	0	0	50,0	0
Put-away	0	50,0	0	50,0
Receiving	8,3	75,0	0	83,3
Stocktaking	8,3	41,7	8,3	66,7
Storage management	14,3	64,3	0	85,7
VAL	0	76,4	2,9	55,9

Table 4.5: The division of features needed in the business units and in use in one or more of the business units in internal operations.

Out of 197 WMS features in the survey there were 55 internal operations specific features. Table 4.6 shows how the features were divided between categories. The largest categories were packing and shipping and value added logistics. The internal processes specific features include functionality such as system reactions on shortages, building of shipping units, dock and yard management, transport devices,

transaction logging, blocking and assembly. The widest functionality is assembly with 9 different features.

Category	Features (n)
3PL services	0
Basic data	1
Order picking	2
Order processing	6
Packing /Shipping	17
Planning	0
Put-away	4
Receiving	2
Stocktaking	4
Storage management	6
VAL	13

Table 4.6: Internal processes specific features.

In the customer specific processes part of the survey there were more variation in the answers. Table 4.7 describes the distribution of answers between the customer types. There were features which were needed in all business units (6,1 percent) only in the consumer and FMCG industry. The consumer and FMCG industry is an important customer industry in all of the business units and has certain characteristics demanding specific functionality from the warehouse management system such as the ability to handle items on the unit level. The amount of features of needed in two business units was quite similar between the industries varying from 39,1 percent of features in automotive industry to 44,7 percent in industrial industry. The features not needed varied between 11,7 and 13,2 percent and features in use from 61,4 percent to 64,0 percent.

Customer group	Needed in all business units (%)	Needed in 2 business units (%)	Needed in 1 business unit (%)	Not needed (%)	In use in 1 or more business units (%)
Automotive	0	39,1	48,2	12,7	61,4
Consumer / FMCG	6,1	41,1	39,6	13,2	64,0
High-tech	0	42,1	45,2	12,7	62,9
Industrial	0	44,7	43,7	11,7	62,4

Table 4.7: The distribution of answers in the customer type specific processes survey.

There were 48 features needed to serve all of the customer industries but not needed in internal operations. 83 features were in common with internal and all different customer type specific processes.

4.1.2.1 Automotive sector

Table 4.8 shows the distribution of answers between the business units in the automotive part of the survey. Two of the business units considered automotive industry specific features needed. Business unit 1 has the considers the automotive industry as an important customer while 71,0 percent of the features in the survey were needed. Business unit 2 considered 16,2 percent of features necessary and business unit 3 does not need any automotive industry specific features in the WMS. Business unit 1 considered 28,4 percent of the features nice to have while the figure for business unit 2 was only 3,1 percent. Business unit 1 has also a larger amount of features currently in use (43,15 percent) compared to business unit 2 which has 10,2 percent of features in use.

Business unit	Needed (%)	Not needed (%)	Nice to have (%)	In use (%)
1	71,0	29,0	28,4	43,15
2	16,2	83,8	3,1	10,2
3	0	100	0	0

Table 4.8: Automotive industry specific features needed, not needed, nice to have and in use in the business units.

None of the features in the automotive industry were needed in all business units. Table 4.9 shows the division of the features needed in the business units by category. The widest functionality needed in two business units is in categories third party services (70,4 percent), receiving (66,7 percent) and basic data (56,3 percent). Other categories range from 0 percent in planning to 40,0 percent in order picking. All features are needed in at least one business unit in the categories third party logistics services, basic data and stocktaking. In 7 out of 11 categories over 50 percent of features are in use in one or two business units.

Nine features out of 197 in the survey were found to be specific to the automotive industry processes. These features included third party logistics master data lines, picking methods, relocation suggestions from the system and sequencing.

Category	Needed in all business units (%)	Needed in 2 business units (%)	Not needed (%)	In use in 1 or more business units (%)
3PL services	0	70,4	0	96,3
Basic data	0	56,3	0	87,5
Order picking	0	40,0	10,0	60,0
Order processing	0	16,7	25,0	58,3
Packing /Shipping	0	28,3	17,4	43,5
Planning	0	0	50,0	0
Put-away	0	25,0	16,7	41,7
Receiving	0	66,7	16,7	83,3
Stocktaking	0	33,3	0	91,7
Storage management	0	21,4	14,3	50,0
VAL	0	35,3	17,7	44,1

Table 4.9: The division of features needed in the business units and in use in one or more of the business units in automotive customer specific operations.

4.1.2.2 FMCG sector

All of the business units have currently customers in the consumer and FMCG industry. Table 4.10 shows the distribution of answers between the business units in the consumer and FMCG part of the survey. The widest functionality is needed in business unit 1 where 74,6 percent of features were considered needed and 24,4 percent were nice to have features. Business unit 2 has needs for a wider functionality in this industry (31,0 percent of features needed) than in the automotive industry (16,2 percent needed). Only 1,5 percent of the features were nice to have -features in business unit 2. Business unit 3 is the smallest with 6,6 percent of features needed and 0 nice to have features. All of the business units have at least some of the features currently in use ranging from 3,6 percent to 43,2 percent.

Business unit	Needed (%)	Not needed (%)	Nice to have (%)	In use (%)
1	74,6	25,4	24,4	43,2
2	31,0	69,0	1,5	21,8
3	6,6	93,4	0	3,6

Table 4.10: Consumer/FMCG customer specific features needed, not needed, nice to have and in use in the business units.

Features in four categories were considered needed in all business units. Table 4.11

shows the division of the features needed in the business units by category. These categories are third party logistics services, basic data, order picking and receiving. Features needed in two business units ranged from 21,4 percent of features in storage management category to 63,0 percent of features in third party logistics services. In 4 categories out of 11 all features were needed in one or more business units. Three of these categories are same as in the automotive industry: third party logistics services, basic data and stocktaking. Additionally also all features in planning is needed at least in one business unit but none of these features are currently in use. 7 of 11 categories have over 50 percent of features currently in use.

Category	Needed in all business units (%)	Needed in 2 business units (%)	Not needed (%)	In use in 1 or more business units (%)
3PL services	25,9	63,0	0	100,0
Basic data	6,3	50,0	0	87,5
Order picking	10,0	50,0	10,0	60,0
Order processing	0	25,0	25,0	66,7
Packing /Shipping	0	39,1	21,7	47,8
Planning	0	50,0	0	0
Put-away	0	25,0	50,0	41,7
Receiving	25,0	50,0	16,7	83,3
Stocktaking	0	41,7	0	91,7
Storage management	0	21,4	7,1	57,1
VAL	0	32,4	23,5	44,1

Table 4.11: The division of features needed in the business units and in use in one or more of the business units consumer/FMCG customer specific operations.

Five features were considered specific only to consumer and FMCG industry processes. These features include calculating the number of required loading aids when building shipping units, using check digit to check the correct loading, blocking by product and automatic stock transfer after assembly operations.

4.1.2.3 High-tech sector

Two of the business units considered high-tech industry specific features needed. Table 4.12 shows the distribution of answers between the business units in the high-tech part of the survey. Business unit 1 considers the high-tech industry as an important

customer while 71,6 percent of the features in the survey were needed. Business unit 2 considers high-tech the second most important industry as 58,9 percent of features are considered necessary and business unit 3 does not need any high-tech industry specific features. Business unit 1 considered 26,9 percent of the features nice to have while the figure for business unit 2 was only 7,1 percent. Business unit 1 has almost the same amount of features in use (43,2 percent) compared to business unit 2 which has 41,1 percent of features in use.

Business unit	Needed (%)	Not needed (%)	Nice to have (%)	In use (%)
1	71,6	28,4	26,9	43,2
2	58,9	43,2	7,1	41,1
3	0	100	0	0

Table 4.12: High-tech customer specific features needed, not needed, nice to have and in use in the business units.

None of the features in the high-tech industry were needed in all business units. Table 4.13 shows the division of the features needed in the business units by category. The largest category in the high-tech sector was third party services with 81,5 percent of features needed in two business units, which is 14,8 percent units more than the second largest category, functionality in receiving. The widest functionality needed in two business units is in five categories: third party services (81,5 percent), receiving (66,7 percent), basic data (56,3 percent), order picking (50,0 percent) and planning (50,0 percent). Other categories range from 16,7 percent in planning to 41,7 percent in stocktaking. All features are needed in at least one business unit in the categories third party logistics services, basic data, planning and stocktaking like in consumer/FMCG industry. In 7 out of 11 categories over 50 percent of features are in use in one or two business units.

Three high-tech industry specific features were found in the results. These include third party logistics invoicing, printing functions in outbound and put-away functionality.

Category	Needed in all business units (%)	Needed in 2 business units (%)	Not needed (%)	In use in 1 or more business units (%)
3PL services	0	81,5	0	100,0
Basic data	0	56,3	0	87,5
Order picking	0	50,0	10,0	60,0
Order processing	0	25,0	25,0	66,7
Packing /Shipping	0	28,3	17,4	43,5
Planning	0	50,0	0	0
Put-away	0	16,7	25,0	41,7
Receiving	0	66,7	16,7	83,3
Stocktaking	0	41,7	0	91,7
Storage management	0	21,4	7,1	57,1
VAL	0	35,3	20,6	44,1

Table 4.13: The division of features needed in the business units and in use in one or more of the business units high-tech customer specific operations.

4.1.2.4 Industrial sector

Two of the business units considered industrial sector customer specific features needed. Table 4.14 shows the distribution of answers between the business units in the industrial part of the survey. Business unit 1 considers the industrial sector as an important customer while 71,6 percent of the features in the survey were needed. Business unit 2 considers industrial sector the most important customer industry as 58,9 percent of features are considered necessary and business unit 3 does not need any industrial sector specific features. Business unit 1 considered 28,4 percent of the features nice to have while the figure for business unit 2 was only 6,1 percent. Business unit 1 has almost the same amount of features in use (43,2 percent) compared to business unit 2 which has 41,1 percent of features in use.

Business unit	Needed (%)	Not needed (%)	Nice to have (%)	In use (%)
1	71,6	28,4	26,9	43,2
2	61,4	38,6	6,1	41,1
3	0	100	0	0

Table 4.14: Industrial customer specific features needed, not needed, nice to have and in use in the business units.

None of the features in the industrial sector were needed in all business units. Table

Category	Needed in all business units (%)	Needed in 2 business units (%)	Not needed (%)	In use in 1 or more business units (%)
3PL services	0	85,2	0	100,0
Basic data	0	62,5	0	87,5
Order picking	0	50,0	10,0	60,0
Order processing	0	25,0	25,0	66,7
Packing /Shipping	0	28,3	17,4	43,5
Planning	0	0	0	0
Put-away	0	16,7	16,7	33,3
Receiving	0	75,0	16,7	83,3
Stocktaking	0	33,3	0	91,7
Storage management	0	28,6	7,1	57,1
VAL	0	44,1	17,7	44,1

Table 4.15: The division of features needed in the business units and in use in one or more of the business units industrial customer specific operations.

4.15 shows the division of the features needed in the business units by category. The largest category in the industrial sector was third party services with 82,5 percent of features needed in two business units. The widest functionality needed in two business units is in four categories: third party services (85,2 percent), receiving (75 percent), basic data (62,5 percent) and order picking (50,0 percent. Other categories range from 0 percent in planning to 44,1 percent in value added logistics. All features are needed in at least one business unit in the categories third party logistics services, basic data, planning and stocktaking like in consumer/FMCG and high-tech sector. In 7 out of 11 categories over 50 percent of features are in use in one or two business units.

Only one industrial customer industry type specific feature was found in the results: using a placement strategy after dangerous goods class.

4.2 Business units

4.2.1 Business unit 1

Business unit 1 is the largest of all the business units participating in the research. It has several warehouses in ten different locations. The biggest customers are from the fast moving consumer goods industry and the automotive industry.

Special needs discussed in the interviews: services included in the portfolio in the future will be assembling, VMI, home call, invoicing and tracking. Current reporting includes inbound preadvice, loading/routing advice, BBD/batch, inventory per location, picking situation reports per customer, efficiency reports and delivery accuracy. Daily reporting includes numerous customer based stock reporting, picking reporting directly to clients by e-mail and 30-50 detailed reports depending of warehouse needs. Critical functions for improving competitiveness are picking sequency and combining picking routes, ABC-analysis for placing goods, more product information to use in processes and batch tracking which increases visibility. The most important improvements to the current WMS are more flexibility to retail customer reports, printouts and picking procedures.

Important functionality:

- Possibility to save more details about goods (items), packaging, storage place, orders, clients, customers and suppliers
- Support for different strategies for put-away, blocking, picking optimization, retrieval
- Automatic functionality: suggestions from the system in relocations, alert functions, automatic plausibility check of delivery orders, reactions on shortages, replenishment, instructions for return
- A wider range of key performance indicators
- Value added logistics functionality such as labeling, repacking, assembly, spare parts, production supply and sequencing

In all customer segments business unit 1 is expanding its 3PL capabilities. Internal operations are the most important part of the warehouse management system after general warehouse functionality. Out of all the customer industries the most features are needed in the fast moving consumer goods industry specific processes. Widest range of functionality is needed in: 3PL services, basic data and essential warehouse processes including order processing and picking, receiving, stocktaking, storage management and packing. Completely new functionality is needed in:

- VAL (sequencing, assembly),
- storage management (blocking, relocations),
- put-away (different placement strategies),

- packing and shipping (building of shipping units, loading),
- 3PL (multi-warehouse system, billing) and
- basic data (storage place information, item master data, units of measure).

4.2.2 Business unit 2

Business unit 2 specializes in cross-border supply chain management and offers special bonded warehouse services. The unit has operation in one location that is central for gaining entry to a larger market area. The unit serves mostly high-tech and consumer goods industries.

Special needs discussed in the interviews: Bonded warehousing functions are crucial for current and future customers. The WMS must be able to handle imported goods and a duty information systems integration would enable a faster customs clearance. Changing ownership of goods both imported and non-imported goods is an important operation in the warehouse. Other important functions in the WMS are tracking and tracing warehouse orders, transfer of shipment data to TMS, a web interface for clients and assembly jobs by employee must be able to monitor.

Important functionality:

- Third party logistics functionality (multi-warehouse, multi-client, invoicing, master data
- Value added logistics functionality: assembly, production supply and sequencing
- Packing and shipping features such as empties handling, building of shipping units, transport devices, dock and yard management

Business needs for general warehouse operations are important excluding value added logistics features. VAL functionality is not considered as important for basic operations as other warehouse processes but it is needed for customer specific processes. Internal and customer specific operations require a wide range of functionality specific for enabling third party logistics business. Some additional features are also needed in basic warehouse operations to enable internal operations. Completely new features are needed in order processing. From the customer categories most features are needed in the industrial and high-tech sector specific processes. However general warehouse and internal needs are emphasized in the results.

4.2.3 Business unit 3

Special needs discussed in the interviews: Daily reporting includes 20-25 different report which will double in the future. In the short term organic growth in the current business area is important but long term plans include expanding the business geographically which includes new types of clients. The most important customer segment is currently the fast moving consumer goods industry and serving this segment is critical of the new system. In warehousing this means working mostly on unit level with short articles and long nomenclature. Cross-docking is typical for this industry and an important feature in the future WMS is cross-docking on unit level.

Important functionality:

- 3rd party logistics related features (Service pricing, multiple warehouses, multi-client capabilities, 3PL related master data)
- Transfer orders related features
- Wide data saving possibilities and data exchange with other systems (item master data, clients, customers and suppliers related data, ASN, goods receipt, order data)
- Manual operations like check digit input, order distribution to multiple warehouses, order release

WMS needs concern improving the basic warehouse operations and internal operations. Widening the WMS functionality for serving the needs of the FMCG industry is important. Widest functionality is needed in different blocking strategies, using the storage space more efficiently and resource planning. Completely new functionality is enabling different units of measure.

4.2.4 Business unit 4

Business unit 4 participated only in the first survey because of problems in the schedule. However, there were informal discussions about the basic processes concerning the first survey. The current warehouse management system in the unit enables basic processes but not functions needed in logistics services so the most important functionality in addition to the basic processes is third party logistics functionality, for example multi-customer warehouses and billing features.

The results of the first survey include major new functionality in planning, stocktaking, storage management and value added logistics. Some new functionality is needed in basic data, order processing, packing and shipping.

4.3 Final WMS feature list

The final feature list is presented in Appendix C. Primary features are category A features, secondary features category B and tertiary features category C. In selecting the warehouse management system it is recommended that the minimum of features the system has are the primary features. The secondary features category is to be used as a guideline if a more extensive system is preferred. Finally the tertiary feature category can be used to further specify the needs if the software packages being compared are all very similar.

Primary features include 309 general warehouse features and 19 internal features. These features include functionality for basic warehouse operations, warehouse management and third-party logistics operations. From warehouse operations three processes have the widest range of features: order processing, put-away and receiving. Warehouse management categories which include planning and stocktaking also have an extensive set of features and a wide array of basic data is also needed. Third party logistics features are also a basic need in this WMS recommendation. However value-added logistics has the least amount of features which is expected as the primary features reflect the absolute basic business needs. The primary features also include several complementary features for enhancing internal operations in third party logistics services and order picking. Some features for internal operations are also found in the categories packing and shipping, receiving, stocktaking and storage management.

Secondary features include additional general warehouse functionality and a wide range of features supporting internal operations. Secondary features also include a range of features for serving different type customer industries. The features are divided as such: general warehouse 94 features, internal operations 119, automotive 77, consumer/FMCG 81, high-tech 83 and industrial 88. 40 secondary features are needed both in internal operations and serving all different customer industries. Third party logistics needs are represented extensively in secondary features while most of these features are needed in customer-specific processes. Additions to basic data are also a large part of the secondary features. The widest range of features concerning general warehouse and internal operations functionality is in the value added logistics category, which was not represented widely in primary features. In internal operations functionality the storage management and order processing

categories are emphasized. Packing and shipping is the most important category in the consumer/FMCG sector related processes.

Tertiary features concentrate on the customer-specific processes. The features are divided as such: general warehouse 27 features, internal operations 49, automotive 95, consumer/FMCG 78, high-tech 89 and industrial 88. Tertiary features include the most functionality in the customer industries. The widest range of features needed in the customer specific processes are in the categories basic data, order processing, stocktaking, storage management and value added logistics. In addition to these categories over 50 percent of packing and shipping features were needed in automotive, high-tech and industrial customer specific processes. In internal processes planning and put-away were emphasized. Because of the strong emphasis on some categories in general warehouse processes in primary and secondary features there were none tertiary features in planning, put-away and value added logistics. In other categories there are some singular features in general warehouse processes but the larger feature clusters that can be separated as distinct functionalities are only in the customer specific processes.

5. CONCLUSIONS

5.1 Discussion

The objective of the research was to define what kinds of business needs the case company has for a new warehouse management system. In the future the case company aims to pursue new clients in different business areas and to develop its internal operations which set requirements for the WMS in addition to the current business needs. The main research question was defined as follows:

- What kind of current and future business needs the company has for the WMS?

The business needs in this research were translated to functional requirements to the warehouse management system. Thus the main research question was divided to three sub-questions which were:

1. What kind of requirements do the general warehouse operations set for the WMS?
2. What kind of requirements do the specific business areas set for the WMS?
3. What kind of requirements do internal operations set for the WMS?

5.1.1 What kind of requirements do the general warehouse operations set for the WMS?

The theoretical part of the study and the general warehouse survey aimed to answer the first research question. The basic warehouse activities were introduced in Chapter 2.2. The general warehouse operations is an area of business that is the most familiar to all of the business units. The empirical part of the study indicates that features enabling the basic warehouse operations are the most important part of the

WMS as 94 percent of the primary features in the final WMS recommendation are general warehouse features. The rest includes internal features.

Initial presumption was that the basic processes were already handled efficiently in all of the business units. Thus customer-specific and internal operations, for example value added logistics and workforce planning, would play a bigger role in specifying the needs for the warehouse management system. However, in all of the participating business units there was a clear need for a better and wider information system support for the basic processes than what the current WMS enabled. The need for optimizing the basic warehouse operations also was emphasized. Iyer (2011) defines these as short-range operational level capabilities. The need to improve and optimize basic warehouse processes is not surprising as the main motivation for using logistics services is improving service and reducing costs (Waters, 2003) and the most outsourced logistics function is warehousing (Rahman, 2011).

One of the important results of the general warehouse management survey was that there were not enough of functionality in all of the current warehouse management systems that support third party logistics operations like multi-client warehouses and billing. This might be because the warehouse management systems in use in the business units varied and were designed at a time when logistics outsourcing was not so common in supply chains. In warehouses operated by a logistics service provider this is an extremely important part of the WMS and should be regarded as a basic requirement. Ten Hompel and Schmidt (2007) also accentuate the importance of taking into account the multi-warehouse, multi-client environment in the warehouse management system. As Luisa dos Santos Vieira et al. (2013) notes logistics outsourcing has been historically one of the largest investors in IT and research links information technology to LSP performance (Wong and Karia, 2010). The lack of third party logistics features in the current information systems indicates that there is a lot of room for improvement with the new warehouse management system.

5.1.2 What kind of requirements do the specific business areas set for the WMS?

Distinguishing customer type specific features and feature sets proved to be difficult. The reason for this may be that because the customer base of the participating units varied too much or that the customer needs may not differ very much in the different industries. The business units have quite a different customer base as business unit 1 has customers in several industries, business unit 2 is heavily specialized in serving

high-tech and industrial customers and business unit 3 has customers only in the consumer goods sector. Ten Hompel and Schmidt (2007) describe the 3PL warehouse management systems as highly transparent general purpose systems. One system has to fit all customers and as the level of utilization of 3PL services varies between customers it is difficult distinguish features specific to one customer type as the system has to cater to all customers at the same time.

Dolgui and Proth (2010) describe differences in warehouse services between customer industries. Value added logistics services are a clear example of the differentiation in services. Industrial customers use services like kitting, assembly and inbound inspections. Automotive industry typically uses spare part services and high-tech industry benefits from mass customization services. (Dolgui and Proth, 2010) Naturally the types of goods warehoused set different requirements for example warehouse operations, information handled in the WMS and planning. In the consumer sector for example food industries can have a wide assortment of products which are purchased in small quantities. Consumer industries are also likely to outsource its logistics in the case of products and materials which need a specific environment in terms of humidity and temperature which is translated directly to WMS requirements (Farahani et al., 2011). Seasonality in the consumer industries affects warehouse throughput and demands careful planning.

Consumer and fast moving consumer goods industry has customers in all of the business units so it was easy to recognize specific attributes in the study that need to be translated into requirements. In the consumer industry e-commerce is a typical challenge for the WMS and sets new requirements to IT (Davarzani and Norrman, 2015). Interviews with the business units' logistics management support this proposition. Other example of specific requirements is that goods are handled and picked at unit level so the WMS needs to be able to handle varying units of measure and information relating to the stock-keeping units.

From the customer specific survey it has to be noted that most of the functionality in the WMS actually serves all customer groups. It was hard to distinguish customer type specific features and feature sets. It might be that there is not enough expertise inside the company for distinguishing specific customer needs. However in the interviews it was clear that the interviewees had knowledge of their current customer groups and specific needs for catering to customers' needs. Increasing flexibility in the operations is one of the reasons for outsourcing logistics functions (Farahani et al., 2011; Waters, 2003). It is possible that the WMS features that bring flexibility to the operations cater to all customer industries thus these features are actually more important than features that serve individual customer industries.

5.1.3 What kind of requirements do internal operations set for the WMS?

The survey on internal and customer specific features and also the interviews indicated that features needed in internal processes were considered more important in terms of performance than features serving specific customer types. Waters (2003); Farahani et al. (2011) discuss the motivation for logistics outsourcing including the need for customized services and effective systems for operations. The internal survey results show that as in the other fields of business also in internal operations the third party logistics functionality is regarded as most important. The basic warehouse operations including receiving, order picking, storage management and shipping included the most functionality after 3rd party logistics related activities. This implies that internal operations are seen as supporting the basic warehouse operations. The interviews also indicated that optimizing processes is considered as one of the most important strategic objectives for the new WMS.

5.2 Evaluation of the study and limitations

The study begun with a period of background research and acquiring material for the survey design and interviews. The researcher did not have previous experience about warehouse operations, so the background research took a lot of time. The first three months of the schedule were conducted as part-time research because of other studies. Using the previous WMS study in the organization as the basis of the surveys sped up the study design considerably. The process models were acquired from a project executed the previous year so the first questionnaire was constructed mirroring the process models to the software features. After designing the first questionnaire the second one was easy to construct with the same format.

Final modifications and the sending of the questionnaires were delayed from the original plan because the differing schedules of the study participants. Acquiring the answers also took more time than planned and in most cases the respondents had to be reminded of the deadlines. Original plan was to acquire answers from all of the business units but eventually only four out of seven units participated in the study. One of the biggest business units did not participate in the study. Also one of the business units that participated in the study does not have a wide range of operations. Thus the basic warehouse functions were strongly emphasized in the results.

The aim of the research was to provide sufficient information for the decision making in the Warehouse Management Project. The study was originally meant to include

all the business units of the company but the participation was voluntary so the coverage of the results reflects the needs of the business units which decided to participate in the study. The aim was to find requirements that are common to all participating business units and in this way generalize the business needs throughout the company. However as the business units and their customers are heterogeneous it is important to keep in mind that the results lean heavily on the similarities between the business units which participated in the research.

5.2.1 Case study quality tests

Case study quality can be assessed with the four quality tests as mentioned in Chapter 1.3. To ensure construct validity in this study multiple sources of evidence were used in the data collection phase: surveys, documentation, archival records and interviews. The chain of evidence can be traced if we follow the chain from conclusions and final WMS recommendation to the research questions. The conclusions for each research question are presented separately and lead to corresponding sections in the results chapter in the case study report. The results are compiled from the case study database which is organized according to the research question themes and includes the interview material, survey material and other documents. Interviews are based on the surveys and survey topics and thus individual questions are linked directly to the original research subquestions. Finally, in the case study composition phase the case study report draft was reviewed by the informants two times.

Internal validity is difficult to establish in this kind of case study because this is a descriptive case study and not explanatory. To ensure that the findings would be reliable the data was presented in different angles, compared from different points of analysis and finally the compiled results were compared with the underlying theory. During the analysis phase some of the different data presentation styles were discarded because they did not present data that would produce any objective conclusions.

External validity was ensured by using the theoretical background as the basis of case study design. The study confirms the results from previous research about third party logistics and IT. However the theoretical background is extensive so unfortunately the results tend to be vague. Limiting the research questions for example to a specific customer sector or warehousing service and having more resources in terms of time and participants in the study would definitely produce better results.

Case study reliability means that the research can be repeated identically so that the researcher would be able to arrive to the same results. The methods and execution

of the case study is documented in Chapter 3 and the surveys are presented in the appendices. The case study material including documentation used in designing the surveys is in the case study database.

5.3 Recommendation for further research

Determining the business needs for a warehouse management system is a topic which is not widely researched. The literature does not describe the functionality of warehouse management systems in detail probably because the coverage of the WMS can vary greatly from the basic warehouse processes to transport management, resource management, value added logistics activities and functionality needed only by logistics service providers. Warehouse management functionality can also be a part of the enterprise resource planning software. However a systematic method for defining organization's business needs for a WMS or any information system would benefit any organizations which are planning to invest in a new information system. Recognizing business needs and translating them into system requirements is a challenging task and among other things demands knowledge of business processes.

Focusing on the information systems of logistics service providers is also an interesting topic for further research. As the findings of this research suggest the information systems currently in use may not be optimal for enabling the core business needs of third party logistics companies. Logistics service providers typically have customers in different industries and catering to the needs of all customer types demands specialized processes and wide IT capabilities. As information system projects often fail it would be interesting to know the success rate in information system projects of logistics service providers and the success factors concerning them.

REFERENCES

Autry, C. W., Griffis, S. E., Goldsby, T. J. and Bobbitt, L. M. (2005), 'Warehouse management systems: resource commitment, capabilities, and organizational performance', *Journal of Business Logistics* **26**(2), 165–183.

Baker, P. (2007), 'An exploratory framework of the role of inventory and warehousing in international supply chains', *The International Journal of Logistics Management* **18**(1), 64–80.

Baudin, M. (2004), 'Lean logistics', *The Nuts and Bolts of Delivering Materials and Goods. Productivity Press, Nowy York* .

Choy, K., Law, K. M., Lenny KOH, S., Lam, C. H., Choy, K. and Chung, S. (2011), 'A decision support system to facilitate warehouse order fulfillment in cross-border supply chain', *Journal of Manufacturing Technology Management* **22**(8), 972–983.

Davarzani, H. and Norrman, A. (2015), 'Toward a relevant agenda for warehousing research: literature review and practitioners' input', *Logistics Research* **8**(1), 1–18.

De Koster, M. and Warffemius, P. (2005), 'American, asian and third-party international warehouse operations in europe: a performance comparison', *International Journal of Operations & Production Management* **25**(8), 762–780.

De Koster, R., Le-Duc, T. and Roodbergen, K. J. (2007), 'Design and control of warehouse order picking: A literature review', *European Journal of Operational Research* **182**(2), 481–501.

Dolgui, A. and Proth, J.-M. (2010), *Supply chain engineering: useful methods and techniques*, Springer Science & Business Media.

Faber, N., de Koster, R. M. B. and van de VELDE, S. L. (2002), 'Linking warehouse complexity to warehouse planning and control structure: an exploratory study of the use of warehouse management information systems', *International Journal of Physical Distribution & Logistics Management* **32**(5), 381–395.

Farahani, R. Z., Rezapour, S. and Kardar, L. (2011), *Logistics operations and management: concepts and models*, Elsevier.

Farquhar, J. D. (2012), *Case study research for business*, Sage.

Gong, Y. and de Koster, R. B. (2011), 'A review on stochastic models and analysis of warehouse operations', *Logistics Research* **3**(4), 191–205.

Gu, J., Goetschalckx, M. and McGinnis, L. F. (2007), 'Research on warehouse operation: A comprehensive review', *European journal of operational research* **177**(1), 1–21.

Gunasekaran, A., Marri, H. and Menci, F. (1999), 'Improving the effectiveness of warehousing operations: a case study', *Industrial Management & Data Systems* **99**(8), 328–339.

Helo, P. and Szekely, B. (2005), 'Logistics information systems: an analysis of software solutions for supply chain co-ordination', *Industrial Management & Data Systems* **105**(1), 5–18.

Iyer, K. N. (2011), 'Demand chain collaboration and operational performance: role of it analytic capability and environmental uncertainty', *Journal of Business & Industrial Marketing* **26**(2), 81–91.

Jeffers, P. I. (2010), 'Embracing sustainability: Information technology and the strategic leveraging of operations in third-party logistics', *International Journal of Operations & Production Management* **30**(3), 260–287.

Koskinen, I., Alasuutari, P. and Peltonen, T. (2005), *Laadulliset menetelmät kauppatieteissä*.

Lai, F., Zhao, X. and Wang, Q. (2007), 'Taxonomy of information technology strategy and its impact on the performance of third-party logistics in china', *International Journal of Production Research* **45**(10), 2195–2218.

Liu, C.-L. and Lyons, A. C. (2011), 'An analysis of third-party logistics performance and service provision', *Transportation Research Part E: Logistics and Transportation Review* **47**(4), 547–570.

Luisa dos Santos Vieira, C., Sérgio Coelho, A. and Mendes Luna, M. M. (2013), 'Ict implementation process model for logistics service providers', *Industrial Management & Data Systems* **113**(4), 484–505.

Lukka, K. (2000), 'The key issues of applying the constructive approach to field research', *Reponen, T.(ed.)* pp. 113–28.

Manzini, R. (2011), *Warehousing in the global supply chain*, Springer.

Marasco, A. (2008), 'Third-party logistics: A literature review', *International Journal of production economics* **113**(1), 127–147.

Min, H. (2006), 'The applications of warehouse management systems: an exploratory study', *International Journal of Logistics: Research and Applications* **9**(2), 111–126.

Murphy, P. and Wood, D. (2004), 'Contemporary logistics, 8e prentice hall, inc', *A Pearson Education Company. New York, NY* .

Power, D., Sharafali, M. and Bhakoo, V. (2007), 'Adding value through outsourcing: Contribution of 3pl services to customer performance', *Management Research News* **30**(3), 228–235.

PwC (2016), 'Shifting patterns: the future of the logistics industry', `https://www.pwc.com/gx/en/industries/transportation-logistics/publications/the-future-of-the-logistics-industry.html`. Accessed: 14.05.2017.

Rahman, S. (2011), 'An exploratory study of outsourcing 3pl services: an australian perspective', *Benchmarking: An international journal* **18**(3), 342–358.

Ramaa, A., Subramanya, K. and Rangaswamy, T. (2012), 'Impact of warehouse management system in a supply chain', *International Journal of Computer Applications* **54**(1).

Robeson, J. F. and William, C. (1994), *Copacino. The Logistics Handbook*, New York, NY: The Free Press: A Division of Macmillan, Inc.

Ross, D. F. (2010), *Introduction to Supply Chain Management Technologies*, CRC Press.

Ross, D. F. (2015), *Distribution Planning and control: managing in the era of supply chain management*, Springer.

Rouwenhorst, B., Reuter, B., Stockrahm, V., Van Houtum, G., Mantel, R. and Zijm, W. (2000), 'Warehouse design and control: Framework and literature review', *European Journal of Operational Research* **122**(3), 515–533.

Rushton, A., Croucher, P. and Baker, P. (2010), 'The handbook of logistics and distribution management, 4th'.

Taylor, G. D. (2007), *Logistics engineering handbook*, CRC press.

Ten Hompel, M. and Schmidt, T. (2007), *Warehouse Management: Automation and Organisation of Warehouse and Order Picking Systems*, Springer.

Van den Berg, J. P. (2007), *Integral Warehouse Management*, Lulu. com.

van den Berg, J. P. and Zijm, W. (1999), 'Models for warehouse management: Classification and examples', *International Journal of Production Economics* **59**(1), 519–528.

Wang, Q., Lai, F. and Zhao, X. (2008), 'The impact of information technology on the financial performance of third-party logistics firms in china', *Supply Chain Management: An International Journal* **13**(2), 138–150.

Waters, D. (2003), *Logistics: an introduction to supply chain management*, Palgrave Macmillan.

Wong, C. Y. and Karia, N. (2010), 'Explaining the competitive advantage of logistics service providers: A resource-based view approach', *International Journal of Production Economics* **128**(1), 51–67.

Yin, R. K. (2003), 'Case study research design and methods third edition', *Applied social research methods series* **5**.

Zakery, A. (2011), '6-logistics future trends', *Logistics Operations and Management: Concepts and Models, Elsevier, London* pp. 93–105.

A. WMS GENERAL SURVEY

WMS features		General Functions		Process
	Feature name	In action	Need	Process number
Item Master Data				
	Article number			
	Item name			
	Customer article number			
	Storage strategy			
	Client			
	Gross weight			
	Net weight			
	Dimensions			
	Different packaging sizes			
	Storage conditions or criteria (temperature, fire prevention ,....)			
	Country of origin			
	Reorder level			
	Reorder quantity			
	Stackability of the item on the load carrier			
	Stackability of the storage unit in block storage			
	Single-level BOM (Bill of Materials)			
	Joint storage ban			
	Article colour (fashion, shoes, textiles)			
	Clothing size (fashion, shoes, textiles)			
	Serial number as a mandatory field			
Package Information				
	Dimensions			
	Weight			
	Packaging type including item number			
	Conversion factor based on the base unit			
Units of Measure				
	Units per weight			
	Units per length, height, width			
	Units per volume			
	Conversion of a unit in another			
Storage Place Information				
	Bin location width (storage location)			
	Bin location depth			
	Bin location height			
	Permissible loading aids			
	Block indicator			
	Capacity: fixed quantity of the same storage unit per storage location (bin location)			
	Capacity: variable quantity of different storage units per storage location			
	Storage unit management: different items in a storage unit			
	Storage unit management: different packaging sizes of the same article on a storage unit			
Master Data Clients, Customers, Suppliers				
	Name			
	Address			
	Contact			
	Phone, fax, e-mail			
	Status indicator / partner role (customer, supplier ,...)			
	Delivery address			
	Additional delivery addresses			

	Packaging requirements / arrangements			
	Delivery instructions / agreements			
	Partial delivery allowed			
Inbound Preadvice (ASN)				
	Manual entry of ASN (Advance ship notice) in the system			
	Collection of ASN by EDI			
	ASN-Number			
	Supplier			
	Planned delivery date			
	Article number			
	Quantity			
	Lot number			
	Production date			
	Serial number			
	Weight			
	Package-ID-Number			
	Packaging scheme used			
	Country of origin			
Goods Receipt				
	Collection and management of unplanned storage receipts			
	Manual identification and entry of data in goods receipt			
	Barcode identification with data transfer in goods receipt			
	Reference to ASN			
	Reference to order			
	Supplier			
	Delivery date			
	Article ID			
	Quantity			
	Lot number			
	Production date			
	Serial number			
	Weight			
	Package-ID-Nr.			
	Country of origin			
	Information about ASN may be covered for the balance goods receipt (shipping note/order data can be used to reconcile the received goods)			
	Accounting for under a ASN - number advised goods are shipped separately			
	Acquisition of goods receipt by the detection of each package			
	Acquisition of goods receipt by the unique acquisition of the part number and quantity			
	Detection of damage in the goods receipt			
	Detection of damage in the goods receipt (damaged goods can be captured during the inspection of the received goods)			
Label Printing at Goods Receipt				
	System support for the labeling of goods by barcode printing			
	Manual reprinting of individual labels			
	Deposit of different label layouts			
Sample Check at Goods Receipt				
	Deposit a fixed sample size per item			
	Deposit a percentage of the sample size per item			
	Deposit of a client-specific sample size			
Comparison of ASN and Goods Receipt				
	Quantity			
	Article ID			

	Damaged goods			
	Serial number			
	Lot number			
	Best before date (BBD)			
	Package-ID-Nr.			
	Weight			
	Packaging scheme used			
	Country of origin			
	Goods received - confirmation to the supplier by paper			
	Goods received - confirmation to the supplier via EDI			
Put-away				
	Manual warehouse space determination			
	Automatic storage space determination according to the stored storage conditions and strategies			
	Support the placement strategy after ABC - Zones			
	Support the placement strategy after height class			
	Support the placement strategy after client			
	Support the placement strategy after temperature classes			
	Support the placement strategy after filling level of the storage areas (eg, 3 IP, or 2 EP)			
	Support the placement strategy after location close to picking area			
	Support the placement strategy after utilization even usage of storage areas such as aisles			
	Support warehousing of only one article to a partially filled storage bin			
	Support warehousing of mixed articles to a partially filled storage bin			
	Control of the correct storage location by manually entering a check number or storage place			
	Control of the correct storage location by scanning the check digit or storage place			
	Automatic determination of an alternative storage location for storage			
Types of Inventory				
	Order point			
	Reporting, minimum, safety stock			
	Available / free stock			
	Reserved stock			
	Quality control stock			
	Mature stock			
	Stock aftercare			
	Scrapping stock			
	Blocked stock			
	Total stock			
Inventory Management				
	Contract-related reservation of articles			
	Storage time monitoring			
	Remaining term monitoring			
	Maturation / quarantine			
	Automatic generation of missing list			
	Automatic generation of back-orders			
Inventory Information				
	Query the inventory information by article number			
	Query the inventory information by batch number			
	Query the inventory information by serial number			
	Query the inventory information by type of packaging			
	Query the inventory information by storage space			
	Query the inventory information by storage area			

	Query the inventory information for client			
Warehouse Control				
	Assignment of articles on picking static hard to place system			
	Assignment of articles on picking dynamic (not fixed assignment)			
	Assignment of articles on picking partially static, partially dynamic (eg dependent on the ABC classification)			
Relocations				
	Direct rearrangement from goods received to goods issue			
	Direct rearrangement from goods received to the picking			
	Direct rearrangement from goods received to the supply area			
	Selective relocation of the source to destination storage bin			
	Targeted voids of storage areas			
Relocations: Suggestions from the System				
	Early provision for the time near the point of outsourcing			
	Rearrangement in the correct ABC zone			
	The creation of open space by combining the same items in partial quantities in a storage bin			
	Consistent use of storage areas			
	Better use of storage space			
Replenishment				
	Managing a minimum and maximum inventory per item for the picking			
	Managing a minimum and maximum inventory per item for the supply or spare area			
	Multi-level replenishment strategy			
Blocking				
	Blocking individual storage areas			
	Locks of predefined storage areas / storage areas			
	Lock-free defined storage areas / storage areas			
	Indication of blocking reason			
	Block of a location for the storage			
	Block of a location for the outsourcing			
	Blocking by item numbers			
	Blocking by part number fields			
	Blocked by batch number			
	Blocked by serial number			
	Blocking by date of production			
	Blocked by client			
Correction Bookings				
	Support for adjustment postings by serial number change			
	Support for adjustment postings by change of Article ID			
	Support for adjustment postings by change in the quantity			
	Support for adjustment postings by modification of the BBD			
	Support for adjustment postings by change in the quality status			
Cancelling Functions				
	Cancellation of ASN			
	Cancellation of an order acceptance			
	Cancellation of the GR posting			
	Cancellation of transfer orders			
	Cancellation of the GI posting			
Alert Functions				
	Alarms if stock falls below the minimum stock			
	Alarms if there is timeout in order processing			
Delivery Orders				
	Direct entry, processing and cancellation of orders			
	Manual transfer of customer orders			

	Automatic acquisition of customer orders (eg EDI)			
	Automatic plausibility check by the system, such as minimum order size, unusually high order volume, unusual items ...			
	Splitting of contracts for various storage areas and commission process			
	Summary of various orders of one customer to a commission assignment			
	Display job status			
	Display an order sheet at the current processing conditions			
Order Data / Header				
	Job number			
	Order			
	Entry date			
	Customer request date			
	Delivery			
	Customer number			
	Delivery address			
	Billing address			
	Transport and transport provision			
	Packing and packaging regulations			
	Value of goods, shipment value, contract value			
	Priority			
	Partial shipment allowed			
Order Data / Lines				
	Article			
	Quantity			
	Unit			
	Customer request date			
	Delivery			
	Packing and packaging regulations			
	Charge			
	Serial Number			
	Maturity			
Availability Check for Delivery Orders				
	Availability from the overall population			
	Availability check from the free / available stock			
	Availability check from the prospective portfolio			
	Availability check from the quality control population			
Reservations for Delivery Orders				
	Reservation of the orders by the sequence			
	Reservation of the orders by customer priority, orders and / or delivery			
Reactions on Shortages				
	Automatic activation of postponed orders for the new goods received			
Order Release				
	Manual order release			
	Automated order release after a predetermined order (eg priority)			
	Automated order release for route planning			
	Automatic order release scheduled (eg, JIT)			
Order Priority				
	Manually changing the job priority			
Picking				
	Break and subsequent continuation of a picking order			
	Automatic assignment of a picking order to the closest commissioner			
Picking Methods				
	Single-stage picking (processing individual customer orders)			

	Two-stage picking			
	Execution of collective orders (multiple orders, one picking)			
	Simultaneous pick (more than one person picking the same order)			
Picking Sequence				
	Order picking to bin location / route instruction to optimize picking			
	Availability check immediately prior to the release of the picking			
	Support of the random response strategy for path optimization			
	Support of the loop path optimization strategy			
	Order of picking by the material weight to optimize picking			
	Order picking by packaging rules to optimize picking			
Picking Order				
	Information providing means for picking with paper list			
	Information providing means for picking with data radio or infrared			
	Information providing means for picking with Pick to Voice			
Pick Check				
	Bin control			
	Article control			
Retrieval				
	Support manual removal strategy			
	FIFO			
	FEFO			
	Outsourcing by the amount			
	Outsourcing by production date			
	Outsourcing by customer-dependent residual life			
	Support automatic selection of alternative subject for outsourcing			
	Arrange the outsourced goods to be picked just before the dispatch time			
Building of Shipping Units				
	Formation of shipping units for item-specific requirements (eg margarine should not be below other items),			
	Formation of shipping units after customers own requirements			
	Formation of shipping units after job-specific requirements			
Information on Shipping Units				
	Weight			
	Geometry data			
Shipping Units Management				
	Loading			
	Gross weight			
	Dimensions			
	Stacking			
	Sales order number			
	Restocking of the completed shipping units commissioned			
	Displaying the shipping units belonging to a specific customer order			
	Displaying the shipping units belonging to a specific shipment			
Goods Issue				
	Recording the batch number in goods issue			
	Recording the serial number in goods issue			
	Tour-related shipment / order combination			
Loading				
	Automatic generation of loading sequence			
Printing Functions in Outbound				
	Printing of specific labels for carriers			
	Production of goods issue papers depending on order			
	Production of goods issue papers depending on client			
	Production of tour-related loading lists			

Inventory / Stocktaking				
	Permanent stock			
	Random sample inventory			
	Periodic inventory			
	Zero crossing inventory			
	Near-zero inventory			
Inventory Process				
	Inventory after storage areas			
	Inventory after item numbers			
	Batch-related inventory			
	Inventory at minimal stock			
	Inventory of the previous day inputs			
	Inventory ignoring inactive parts			
	Basic inventory of unit loads			
	Generating a list of all articles of which last inventory was X days ago.			
	Different types of inventory for different storage areas			
	Different types of inventory for different items			
	Different types of inventory for different clients			
	Different time points for each inventory storage area			
	Paper-based implementation of the inventory (print a list of storage locations to be inventoried)			
	Implementation of the inventory by using wireless terminals			
Inventory Report				
	Transmission of the inventory reports as printouts			
	Transmission of the inventory reports via EDI			
Transaction Logging				
	Storing the job reference in the stock movement log			
	Storing the batch in the stock movement log			
	Storing the date of entry and exit in the stock movement log			
	Storing the storage / shipping container in the stock movement log			
	Storing the goods movement type in the stock movement log			
	Storing the storage bin in the stock movement log			
	Storing the item number in the stock movement log			
	Storing the amount in the stock movement log			
	Storing the serial number in the stock movement log			
Queries / Reports				
	Possibility of reports (fixed predetermined reports)			
	Possibility of defining the input parameters for given reports			
	Users can sort reports by specified fields			
	Representation of the query results one record per page			
	Representation of the query results as lists			
	Storage of reports in Excel format			
	Save the report as ASCII file			
Standard Forms / Printouts				
	Storage list			
	Warehousing labels			
	Goods receipt confirmation			
	Order-picking lists			
	Delivery notices			
	Loading lists			
	Additional loading lists by shipping units			
	Waybill			
	Goods issue confirmation			
	Customs form T1 (goods issue)			

	Pro forma invoice (for clearing low-value items)			
	Address labels for shipping			
	Shipping labels for company transport system (for example, Mistral)			
	Invoice on behalf of the customer			
	Invoice for warehouse services			
	Detailed list of the warehouse services that took place (for example, rent, type of service)			
KPI's				
	Avg. Remaining time of an item in the warehouse			
	Time spent per order, customer, client, transportation, activity, storage area, staff.			
	Determine the workload per employee			
	Determine the workload per transport type			
	Determine the workload per bearing zone			
	Determine the workload as a combination of the above criteria			
	Determination of stock items per product group			
	Determination of stock items per bearing zone			
	Determination of stock items as a combination of the above criteria			
	Filling ratio per bin			
	Degree of filling per each storage zone			
	Degree of filling per store type			
	Degree of filling for each client			
	Query for timely / late deliveries			
	Query for the complete / incomplete deliveries			
	Query the supplier to deliver quality			
	Query the supplier quality for the respect of the delivery date			
	Query on the deviation of the supplier quality target-sets			
	Query the supplier quality on the quality of delivery			
	Query tracking events dep. from customer order			
	Query tracking events dep. the customer			
	Query tracking events dep. from supplier			
	Query tracking events dep. of article			
	Query tracking events dep. of the charge			
	Summary report for all item master data			
	Overview report for the item master data from a client			
	KPI à receipts per day			
	KPI à receiving positions per day			
	KPI à orders per day			
	KPI à order items per day			
	KPI à number of shipping units per day			
	KPI à total weight of goods shipped per day			
	KPI à throughput per day			
	KPI à inventory per day			
	KPI à stock per product group			
	KPI à Stock Overview over time			
	KPI à number of inventory items for a period			
	KPI à number of items with stock movement for a period			
	KPI à stock movement based ABC analysis			
	KPI à list of items with inventory deficit			
	KPI à inventory days			
	KPI à list of the outstanding orders			
	KPI à list of inventory corrections			
	KPI à- delivery date accuracy			
	KPI à delivery volume accuracy			

	KPI à comparison of delivery / returns for a period			
	Statistics / KPI 's are available for each client			
	Evaluation of storage time per item			
	Evaluation of shelf-life as a combination of item / customer (an article or more)			
Internet Access				
	Internet access for clients: stock information			
Batch Number Handling				
	Batch management is available			
	Management of more than one batch number simultaneously			
	Management of information of a batch (production date, expiry date, quality criteria, composition)			
	Continuous tracking of batches by the supplier			
	Continuous reference of the batches to the customer			
Serial Number Handling				
	Serial numbers is available			
	Continuous tracking of serial numbers according to the supplier			
	Continuous reference of serial number according to the customer			
	Enter serial number ranges			
	Continuous tracking of the serial number range for the supplier			
	Continuous-reference the serial number ranges to the customer			
Multiple Clients				
	Multiple client -capable system			
	Fixed assignment of a location / storage area to a client			
	Dynamic allocation of a location / storage area to a client			
	Transfer of resources from one client to another client			
Multiple Warehouses				
	Multi-warehouse system			
	Allocation of a customer to a warehouse			
	Assignment of a supplier to a warehouse			
	Allocation of an article to a warehouse			
Empties Handling				
	Unambiguous (clear) identification of the loading aids			
Returns				
	Processing of returns with respect to originally Order			
	Receipt of goods as normal goods received (if possible)			
	Management of returned goods (reason)			
Data Exchange with other Systems				
	Item master data			
	Order data			
	Stock data			
	Order data / ASN			
	Inventory data			
	Customer data			
	Inward stock movement data			
	Supplier master data			
	Order-picking control systems			
	Labeling system			
	Weighing System			
Resource Planning				
	Employee-related resource planning (ie, information about usage, orders, necessary staff and existing staff in the system can be deposited)			
	Taking into account the qualifications, hours of work allowed, activities and range of staff in resource planning			

	Employee-related resources planning, taking into account the standard time			
	Update of the standard time based on the activities carried out			
	Update of the standard time based on the activities carried out			
	Determination of the total processing time of a task			
	Determine the starting time of a task			
	Notification of deviations in actual and processing times			
Assembly				
	Deposit-stage BOMs			
	Manual entry of assembly and disassembly jobs			
	Release of BOM (Bill of Materials)			
	Automatic generation of work orders, if the finished product or the item is no longer sufficient available			
	Management of the serial numbers of the components used for the finished product or the product			
Repacking				
	Consideration of various requirements of repackaging (eg, Article, client, customer ...)			
	Different instructions to various criteria, eg per item, client, customer ...			
	Support for supplies needed for carrier / packing material			
	Query used materials for repackaging			
	Deposit of standard times for the repackaging			
	Update of the standard time for repacking the basis of the activities			
	Storing the actual time required for the repackaging			
Labeling				
	Support for different label formats			
	Deposit different labeling instructions			
	Query made by labeling			
	Deposit of standard time for the labeling			
	Storing the actual time needed for labeling			
	Update label using standard time-related activities carried out			
Customs				
	Deposit of duty ID for the entire delivery			
	Deposit of duty-ID for specific positions in the delivery			

B. WMS INTERNAL AND CUSTOMER SURVEY

	Feature name	Automotive			Consumer/FMCG			High-tech			Industrial			Internal		
		In use	Need	Nice to have	In use	Need	Nice to have	In use	Need	Nice to have	In use	Need	Nice to have	In use	Need	Nice to have
Item Master Data																
	Spare part number															
	Supplier item number															
	Category / Product Group															
	Customs tariff number (code)															
	Multi-level BOM (bill of materials)															
	Value															
	Currency															
	Charge field as a mandatory field															
	More than one currency															
Units of Measure																
	Create additional units possible															
Storage Place Information																
	Weights for each storage location															
	Weights per storage row (aisle)															
	Weights for each storage column															
	Weights for each storage zone															
	Storage conditions for each product group															
	Storage conditions for each storage zone															
Master Data Clients, Customers, Suppliers																
	Billing Address															
	Classifications (eg, payment behavior, delivery reliability, ...)															
	Conditions / prices															
	Credit line															
	Invoicing in favor of customer															
Inbound Preadvice (ASN)																
	best-before date (BBD)															

Goods Receipt																	
	best-before date (BBD)																
	Packaging scheme used																
	Deposit of item-specific work instructions like packaging instructions																
	Serial number																
	Platform																
Sample Check at Goods Receipt																	
	Depositing a formula for calculating the sample size per item																
	Deposit of a vendor-specific sample size																
Comparison of ASN and Goods Receipt																	
	goods received - confirmation by confirming the full payment advices (Confirmation of the complete advanced shipping note)																
	goods received - (Partial confirmation of the advance shipping note for the respective partial delivery)																
	goods received - (Individual confirmation of each item)																
Put-away																	
	Support the placement strategy after Single item																
	Support the placement strategy after charge storage																
	Support the placement strategy after fairground system per item																
	Support the placement strategy after fairground system per item group / class																
	Support the placement strategy after weight classes (heavy to the bottom, light above)																
	Support the placement strategy after dangerous classes																
	Support the placement strategy after equal distribution of items in stock areas such as alleys																
	Support the placement strategy after handling capacity																
	Support the input and additional storage per loading equipment with the same BBD																
	Support the input and additional storage per load support with the different BBD																
	Support the input and additional storage per loading equipment with the same batch number																

	Support the input and additional storage per loading devices with different lot numbers																
Types of Inventory																	
	In transit in procurement																
	In transit in distribution																
Inventory Management																	
	Automatic suggestion of defined alternative products																
	Generation of orders for various methods																
Warehouse Control																	
	Double Play (combined input / retrieval)																
Relocations: Suggestions from the System																	
	Early provision for the time near the point of outsourcing																
	The creation of open space by aggregation of a different article at a storage place																
	Equal distribution of items in stock areas																
Replenishment																	
	Automatic request of filling up of a commission area																
	Automatic request of filling up the supplies or spare area																
	Freely configurable replenishment strategies																
Blocking																	
	Blocked by serial number range																
	Blocked by BBD (Best before date)																
	Blocked by platform																
	Blocked by SSCC (Serial shipping container code)																
	Blocked by product																
Correction Bookings																	
	Support for adjustment postings according to change in the batch number																
Alert Functions																	
	Alarm at the impending overrun of BBD																
Delivery Orders																	
	Automatic conversion of units of the order item in stock customary units																

Availability Check for Delivery Orders																	
	Availability check in the light of duty-unpaid stock																
Reactions on Shortages																	
	Rejection of jobs that can not be operated completely																
	Provision of jobs that can not be operated completely																
	Confirmation of the deliverable supply contract with the rejection of the non-deliverable part order																
	Confirmation of the deliverable supply contract with provision of the non-deliverable part order																
Order Release																	
	Automated order release criteria for utilization																
	Zero quantity acknowledgement																
	Backorder management																
Order Priority																	
	Automatic time-dependent increase in the priority																
Picking																	
	Acquisition of picking orders from external application																
	Dynamic pick optimization																
	Rounding up/down for suitable pick quantity																
Picking Methods																	
	Picking waves																
	Negative-picking																
Picking Strategies																	
	Inventory rotation methods (FIFO, FEFO, etc)																
	Product pick order generation (discreet, linear, item load)																
	Pick for speed																
Picking Order																	
	Information providing means for picking Pick to Light																
Retrieval																	
	Support automatic selection of alternative subject for outsourcing																
Building of Shipping Units																	

	Formation of shipping units to the loading equipment-specific requirements (eg, weight limit)																
	Selection of the loading medium for the formation of shipping units																
	Calculating the number of required loading aids in the formation of shipping units																
	Exact allocation of items and quantities on the loading equipment (including shipping mixed units) (proposal for picking)																
	Specification of the picking sequence according to the formation of shipping units																
	Generation of packing patterns																
	Consideration of packaging rules for the formation of Shipping Units																
	Consideration of co-pack bans for the formation of shipping units																
	Packaging management concerning different types of rolling cages																
	Packaging management concerning different planes																
	Packaging management concerning different types of pallets																
Information on Shipping Units																	
	Classification																
	Content declaration (content of the shipping unit)																
Shipping Units Management																	
	Display the shipping units belonging to a tour																
Goods Issue																	
	Generation of SSCC (Serial Shipment Container Code)																
	Support the multi-level management of SSCC (for example which SSCC have the pallets in the container at a predetermined SSCC)																
	Support for controlling freight costs																
Loading																	
	Check the correct loading by manual entry of a check digit																
	Check the correct loading of the check digit by scanning																
Shipping																	

	Determining the optimal dispatch at various criteria (eg, weight, delivery time, customer requirements ...)																
	Manual handling equipment selection for a tour																
	Automatic handling equipment selection for a tour as depending on destination, shipping charges																
	Manual carrier mapping for a Tour																
	Automatic carrier allocation for a tour																
Printing Functions in Outbound																	
	Production of goods issue papers depending on other criteria (such as sales, shipping, carrier ...)																
Inventory Process																	
	Interfaces to the acquisition of external requirements for inventory																
	Prioritization of the inventory-related transportation contracts so that normal operation is not disturbed																
	Different time points for each inventory item																
	Different points in time inventory for each client																
Transaction Logging																	
	Storage of the container type in the stock movement log																
	record of the BBD in the inventory movement log																
	reason for goods received / goods issue (supply, return, ...)																
Multiple Clients																	
	Storage of the stock of different clients in a storage bin																
Multiple Warehouses																	
	Manual distribution of an order to multiple warehouses																
	Automatic distribution of an order to multiple warehouses																
	Manual distribution of individual order items at multiple warehouses																
	Automatic distribution of individual order items at multiple warehouses																
	Procurement of supplies between two warehouses																
Empties Handling																	
	Cause of empties and Loading Equipment accounts per customer																

	Cause of empties and Loading Equipment accounts per shipping address																
	Generating return pick-ups for empty / LCs																
Returns																	
	Automatic introduction of required steps by the system in case of a return																
Data Exchange with other Systems																	
	Outward stock movement data																
	Transport System																
	Management of information about transportation, such as type, max. Load / capacity, range of application, allowed items / load support, performance indicators etc.																
	Support a load-dependent transportation choice																
	Path optimization within a transfer order																
	Sequence optimization over several orders																
	Transportgutabhängigen support a transportation choice																
	Integrated stacker control system (ie, survey of current tasks and means of transport / resources, manual / automatic assignment of tasks to resources, prioritize tasks, review of overdue tasks, including basic ...)																
	Cause of transportation statistics (hours of use, frequency of use ,...)																
	Automatic collection of information on transportation, such as operating time, number of transfer orders, maintenance, incidents, ...																
Dock & Yard Management																	
	Dock and yard management features are available																
	Is the system of the contents of the trucks known? (Linking a delivery truck with advices)																
	Deposit of targeted delivery times (inwards)																
	Deposit of delivery target times (outwards)																
	Manual assignment of a truck at a dock																
	Automatic assignment of a truck at a dock in the light of target times																
	Automatic assignment of a truck at a dock in prioritization of urgently needed goods																

	Automatic assignment of a truck at a dock with route optimization																
Resource Planning																	
	Transportation-related resource planning, taking account of the performance ratios of means of transport, availability of transport, the application range of means of transport																
	Transportation-related resources planning taking into account the standard time																
Assembly																	
	Two-stage deposit bills																
	Deposit multilevel BOMs																
	View the assembly instructions																
	Generation of transport requests for re-storage of the finished product / item																
	Automatic generation of picking and transport contracts for the components of a finished product / item according to the parts list																
	Deposit of a batch size of finished products / articles																
	Deposit of assembly instructions to various criteria, eg client, customer, order ...																
	Stepwise viewing of assembly instructions																
	Multi-stage assembly of several assembly areas across																
	Assembly of the intermediates and then merge																
	Automatic stock transfer after confirmation of the assembly and disassembly operations																
	Deposit of standard times for the assembly operation																
	Storing the actual time needed for assembly																
	Update of installation using the standard time-related activities carried out																
	Management of batch numbers of used components for the end product or the item																
Invoicing / Billing of Warehouse Services																	
	Deposit of prices for services																
	Different prices for identical services depending of the article																
	Different prices for identical services depending of the customer																

	Different prices for identical services depending of from client																
	Different prices for identical services depending of from supplier																
	Deposit of tiered pricing for services																
	Determination of the warehouse services provided per client																
	Determination of the warehouse services provided per customer order																
	Determination of the warehouse services provided per customer																
	Determination of the warehouse services provided by supplier																
	Determination of the warehouse services provided per item																
	Determination of the warehouse services provided by batch																
	Generation of invoices for services rendered per client																
	Generating invoices for the services provided by supplier																
	Generation of invoices for services rendered per client																
	Product or order type based invoicing depending on client's business area																
Customs																	
	Intrastat - Login																
	Booking of uncleared goods for sales orders																
Part ID's																	
	Management of Part ID's																
	Registration of additional information for Part ID																
Production Supply																	
	Management of deliveries to the production line based on standard times per item																
	Management of deliveries to the production line based on standard times per item and point of use																
	Combination of delivery orders in one delivery to the production line (route planning)																
	Manual change of route planning																
	Validity period per item																
	Validity period per item and point of use																
	Registration of substitution item for item with limited validity																

	At expiration of validity: expired item is automatically blocked for picking																
	At expiration of validity: warning message at next call-off for expired item																
	At expiration of validity: automatic choice of substitution item at next call-off for expired item																
	Report of all expired items																
Kanban																	
	Management of paper-based Kanban cycles																
	Management of electronic Kanban cycles																
Sequencing																	
	Management of the sequence of parts in a special rack delivered to the production line																
	Picker gets information on mobile terminal about position of the part on the rack.																
	Booking of goods issue for complete delivery (all parts on the rack)																
	Booking of goods issue for each part separately																

C. WMS FEATURE RECOMMENDATION

Category A features

Business area	WMS Function	Feature
General warehouse	Assembly	Release of BOM (Bill of Materials)
General warehouse	Batch Number Handling	Batch management is available
General warehouse	Batch Number Handling	Management of information of a batch (production date, expiry date, quality criteria, composition)
General warehouse	Batch Number Handling	Management of more than one batch number simultaneously
General warehouse	Blocking	Block of a location for the outsourcing
General warehouse	Blocking	Block of a location for the storage
General warehouse	Blocking	Blocked by batch number
General warehouse	Blocking	Blocked by client
General warehouse	Blocking	Blocking by date of production
General warehouse	Blocking	Blocking by item numbers
General warehouse	Blocking	Blocking by part number fields
General warehouse	Blocking	Blocking individual storage areas
General warehouse	Blocking	Indication of blocking reason
General warehouse	Blocking	Locks of predefined storage areas / storage areas
General warehouse	Building of Shipping Units	Formation of shipping units after customers own requirements
General warehouse	Building of Shipping Units	Formation of shipping units for item-specific requirements (eg margarine should not be below other items),
General warehouse	Cancelling Functions	Cancellation of an order acceptance
General warehouse	Cancelling Functions	Cancellation of ASN
General warehouse	Comparison of ASN and Goods Receipt	Article ID
General warehouse	Comparison of ASN and Goods Receipt	Damaged goods
General warehouse	Comparison of ASN and Goods Receipt	Goods received - confirmation to the supplier by paper
General warehouse	Comparison of ASN and Goods Receipt	Lot number
General warehouse	Comparison of ASN and Goods Receipt	Quantity
General warehouse	Comparison of ASN and Goods Receipt	Serial number
General warehouse	Comparison of ASN and Goods Receipt	Weight
General warehouse	Correction Bookings	Support for adjustment postings by change in the quantity
General warehouse	Correction Bookings	Support for adjustment postings by change of Article ID
General warehouse	Correction Bookings	Support for adjustment postings by serial number change
General warehouse	Data Exchange with other Systems	Customer data
General warehouse	Data Exchange with other Systems	Inventory data
General warehouse	Data Exchange with other Systems	Item master data
General warehouse	Data Exchange with other Systems	Order data
General warehouse	Data Exchange with other Systems	Order data / ASN
General warehouse	Data Exchange with other Systems	Order-picking control systems
General warehouse	Data Exchange with other Systems	Stock data
General warehouse	Data Exchange with other Systems	Supplier master data
General warehouse	Delivery Orders	Automatic acquisition of customer orders (eg EDI)
General warehouse	Delivery Orders	Direct entry, processing and cancellation of orders
General warehouse	Delivery Orders	Display an order sheet at the current processing conditions
General warehouse	Delivery Orders	Display job status
General warehouse	Delivery Orders	Manual transfer of customer orders
General warehouse	Delivery Orders	Splitting of contracts for various storage areas and commission process
General warehouse	Delivery Orders	Summary of various orders of one customer to a commission assignment
General warehouse	Goods Receipt	Accounting for under a ASN - number advised goods are shipped separately
General warehouse	Goods Receipt	Acquisition of goods receipt by the unique acquisition of the part number and quantity
General warehouse	Goods Receipt	Article ID
General warehouse	Goods Receipt	Barcode identification with data transfer in goods receipt
General warehouse	Goods Receipt	Collection and management of unplanned storage receipts
General warehouse	Goods Receipt	Country of origin
General warehouse	Goods Receipt	Delivery date
General warehouse	Goods Receipt	Detection of damage in the goods receipt
General warehouse	Goods Receipt	Detection of damage in the goods receipt (damaged goods can be captured during the inspection of the received goods)
General warehouse	Goods Receipt	Information about ASN may be covered for the balance goods receipt (shipping note/order data can be used to reconcile the received goods)
General warehouse	Goods Receipt	Lot number
General warehouse	Goods Receipt	Manual identification and entry of data in goods receipt

Category A features

General warehouse	Goods Receipt	Package-ID-Nr.
General warehouse	Goods Receipt	Production date
General warehouse	Goods Receipt	Quantity
General warehouse	Goods Receipt	Reference to ASN
General warehouse	Goods Receipt	Reference to order
General warehouse	Goods Receipt	Serial number
General warehouse	Goods Receipt	Supplier
General warehouse	Goods Receipt	Weight
General warehouse	Inbound Preadvice (ASN)	Article number
General warehouse	Inbound Preadvice (ASN)	ASN-Number
General warehouse	Inbound Preadvice (ASN)	Collection of ASN by EDI
General warehouse	Inbound Preadvice (ASN)	Country of origin
General warehouse	Inbound Preadvice (ASN)	Lot number
General warehouse	Inbound Preadvice (ASN)	Manual entry of ASN (Advance ship notice) in the system
General warehouse	Inbound Preadvice (ASN)	Package-ID-Number
General warehouse	Inbound Preadvice (ASN)	Planned delivery date
General warehouse	Inbound Preadvice (ASN)	Production date
General warehouse	Inbound Preadvice (ASN)	Quantity
General warehouse	Inbound Preadvice (ASN)	Serial number
General warehouse	Inbound Preadvice (ASN)	Supplier
General warehouse	Inbound Preadvice (ASN)	Weight
General warehouse	Information on Shipping Units	Geometry data
General warehouse	Information on Shipping Units	Weight
General warehouse	Internet Access	Internet access for clients: stock information
General warehouse	Inventory / Stocktaking	Periodic inventory
General warehouse	Inventory / Stocktaking	Permanent stock
General warehouse	Inventory / Stocktaking	Random sample inventory
General warehouse	Inventory / Stocktaking	Zero crossing inventory
General warehouse	Inventory Information	Query the inventory information by article number
General warehouse	Inventory Information	Query the inventory information by batch number
General warehouse	Inventory Information	Query the inventory information by serial number
General warehouse	Inventory Information	Query the inventory information by storage area
General warehouse	Inventory Information	Query the inventory information by storage space
General warehouse	Inventory Information	Query the inventory information by type of packaging
General warehouse	Inventory Information	Query the inventory information for client
General warehouse	Inventory Management	Contract-related reservation of articles
General warehouse	Inventory Management	Remaining term monitoring
General warehouse	Inventory Management	Storage time monitoring
General warehouse	Inventory Process	Batch-related inventory
General warehouse	Inventory Process	Different types of inventory for different clients
General warehouse	Inventory Process	Different types of inventory for different storage areas
General warehouse	Inventory Process	Generating a list of all articles of which last inventory was X days ago.
General warehouse	Inventory Process	Implementation of the inventory by using wireless terminals
General warehouse	Inventory Process	Inventory after item numbers
General warehouse	Inventory Process	Inventory after storage areas
General warehouse	Inventory Process	Inventory at minimal stock
General warehouse	Inventory Process	Paper-based implementation of the inventory (print a list of storage locations to be inventoried)
General warehouse	Inventory Report	Transmission of the inventory reports as printouts
General warehouse	Inventory Report	Transmission of the inventory reports via EDI
General warehouse	Item Master Data	Article colour (fashion, shoes, textiles)
General warehouse	Item Master Data	Article number
General warehouse	Item Master Data	Client
General warehouse	Item Master Data	Clothing size (fashion, shoes, textiles)
General warehouse	Item Master Data	Country of origin
General warehouse	Item Master Data	Customer article number
General warehouse	Item Master Data	Different packaging sizes
General warehouse	Item Master Data	Dimensions
General warehouse	Item Master Data	Gross weight
General warehouse	Item Master Data	Item name
General warehouse	Item Master Data	Net weight
General warehouse	Item Master Data	Serial number as a mandatory field
General warehouse	Item Master Data	Single-level BOM (Bill of Materials)

Category A features

General warehouse	Item Master Data	Stackability of the storage unit in block storage
General warehouse	Item Master Data	Storage conditions or criteria (temperature, fire prevention ,....)
General warehouse	Item Master Data	Storage strategy
General warehouse	KPI's	Avg. Remaining time of an item in the warehouse
General warehouse	KPI's	Degree of filling for each client
General warehouse	KPI's	Degree of filling per each storage zone
General warehouse	KPI's	Degree of filling per store type
General warehouse	KPI's	Determination of stock items as a combination of the above criteria
General warehouse	KPI's	Determination of stock items per bearing zone
General warehouse	KPI's	Determination of stock items per product group
General warehouse	KPI's	Determine the workload per employee
General warehouse	KPI's	Determine the workload per transport type
General warehouse	KPI's	Filling ratio per bin
General warehouse	KPI's	KPI à comparison of delivery / returns for a period
General warehouse	KPI's	KPI à inventory days
General warehouse	KPI's	KPI à inventory per day
General warehouse	KPI's	KPI à list of inventory corrections
General warehouse	KPI's	KPI à list of the outstanding orders
General warehouse	KPI's	KPI à number of inventory items for a period
General warehouse	KPI's	KPI à number of items with stock movement for a period
General warehouse	KPI's	KPI à number of shipping units per day
General warehouse	KPI's	KPI à order items per day
General warehouse	KPI's	KPI à orders per day
General warehouse	KPI's	KPI à receipts per day
General warehouse	KPI's	KPI à receiving positions per day
General warehouse	KPI's	KPI à stock movement based ABC analysis
General warehouse	KPI's	KPI à stock per product group
General warehouse	KPI's	KPI à throughput per day
General warehouse	KPI's	KPI à total weight of goods shipped per day
General warehouse	KPI's	KPI à- delivery date accuracy
General warehouse	KPI's	Overview report for the item master data from a client
General warehouse	KPI's	Query for the complete / incomplete deliveries
General warehouse	KPI's	Query for timely / late deliveries
General warehouse	KPI's	Query the supplier quality for the respect of the delivery date
General warehouse	KPI's	Query the supplier to deliver quality
General warehouse	KPI's	Statistics / KPI 's are available for each client
General warehouse	KPI's	Summary report for all item master data
General warehouse	KPI's	Time spent per order, customer, client, transportation, activity, storage area, staff.
General warehouse	Label Printing at Goods Receipt	Manual reprinting of individual labels
General warehouse	Label Printing at Goods Receipt	System support for the labeling of goods by barcode printing
General warehouse	Labeling	Deposit different labeling instructions
General warehouse	Labeling	Deposit of standard time for the labeling
General warehouse	Labeling	Storing the actual time needed for labeling
General warehouse	Labeling	Support for different label formats
General warehouse	Labeling	Update label using standard time-related activities carried out
General warehouse	Loading	Automatic generation of loading sequence
General warehouse	Master Data Clients, Customers, Suppliers	Additional delivery addresses
General warehouse	Master Data Clients, Customers, Suppliers	Address
General warehouse	Master Data Clients, Customers, Suppliers	Contact
General warehouse	Master Data Clients, Customers, Suppliers	Delivery address
General warehouse	Master Data Clients, Customers, Suppliers	Delivery instructions / agreements
General warehouse	Master Data Clients, Customers, Suppliers	Name
General warehouse	Master Data Clients, Customers, Suppliers	Packaging requirements / arrangements
General warehouse	Master Data Clients, Customers, Suppliers	Partial delivery allowed
General warehouse	Master Data Clients, Customers, Suppliers	Phone, fax, e-mail
General warehouse	Master Data Clients, Customers, Suppliers	Status indicator / partner role (customer, supplier ,...)
General warehouse	Multiple Clients	Dynamic allocation of a location / storage area to a client
General warehouse	Multiple Clients	Fixed assignment of a location / storage area to a client
General warehouse	Multiple Clients	Multiple client -capable system
General warehouse	Multiple Warehouses	Allocation of a customer to a warehouse
General warehouse	Order Data / Header	Billing address
General warehouse	Order Data / Header	Customer number

Category A features

General warehouse	Order Data / Header	Customer request date
General warehouse	Order Data / Header	Delivery
General warehouse	Order Data / Header	Delivery address
General warehouse	Order Data / Header	Entry date
General warehouse	Order Data / Header	Job number
General warehouse	Order Data / Header	Order
General warehouse	Order Data / Header	Packing and packaging regulations
General warehouse	Order Data / Header	Partial shipment allowed
General warehouse	Order Data / Header	Priority
General warehouse	Order Data / Header	Transport and transport provision
General warehouse	Order Data / Header	Value of goods, shipment value, contract value
General warehouse	Order Data / Lines	Article
General warehouse	Order Data / Lines	Charge
General warehouse	Order Data / Lines	Customer request date
General warehouse	Order Data / Lines	Delivery
General warehouse	Order Data / Lines	Maturity
General warehouse	Order Data / Lines	Packing and packaging regulations
General warehouse	Order Data / Lines	Quantity
General warehouse	Order Data / Lines	Serial Number
General warehouse	Order Data / Lines	Unit
General warehouse	Order Priority	Manually changing the job priority
General warehouse	Order Release	Automated order release after a predetermined order (eg priority)
General warehouse	Order Release	Manual order release
General warehouse	Package Information	Conversion factor based on the base unit
General warehouse	Package Information	Dimensions
General warehouse	Package Information	Packaging type including item number
General warehouse	Package Information	Weight
General warehouse	Pick Check	Article control
General warehouse	Picking	Break and subsequent continuation of a picking order
General warehouse	Picking Methods	Simultaneous pick (more than one person picking the same order)
General warehouse	Picking Methods	Single-stage picking (processing individual customer orders)
General warehouse	Picking Order	Information providing means for picking with data radio or infrared
General warehouse	Picking Order	Information providing means for picking with paper list
General warehouse	Picking Sequence	Order of picking by the material weight to optimize picking
General warehouse	Picking Sequence	Order picking by packaging rules to optimize picking
General warehouse	Picking Sequence	Order picking to bin location / route instruction to optimize picking
General warehouse	Printing Functions in Outbound	Printing of specific labels for carriers
General warehouse	Printing Functions in Outbound	Production of goods issue papers depending on client
General warehouse	Printing Functions in Outbound	Production of goods issue papers depending on order
General warehouse	Printing Functions in Outbound	Production of tour-related loading lists
General warehouse	Put-away	Automatic storage space determination according to the stored storage conditions and strategies
General warehouse	Put-away	Control of the correct storage location by manually entering a check number or storage place
General warehouse	Put-away	Control of the correct storage location by scanning the check digit or storage place
General warehouse	Put-away	Manual warehouse space determination
General warehouse	Put-away	Support the placement strategy after ABC - Zones
General warehouse	Put-away	Support the placement strategy after client
General warehouse	Put-away	Support the placement strategy after height class
General warehouse	Put-away	Support the placement strategy after location close to picking area
General warehouse	Put-away	Support warehousing of mixed articles to a partially filled storage bin
General warehouse	Put-away	Support warehousing of only one article to a partially filled storage bin
General warehouse	Queries / Reports	Possibility of defining the input parameters for given reports
General warehouse	Queries / Reports	Possibility of reports (fixed predetermined reports)
General warehouse	Queries / Reports	Representation of the query results as lists
General warehouse	Queries / Reports	Representation of the query results one record per page
General warehouse	Queries / Reports	Storage of reports in Excel format
General warehouse	Queries / Reports	Users can sort reports by specified fields

Category A features

General warehouse	Relocations	Direct rearrangement from goods received to goods issue
General warehouse	Relocations	Selective relocation of the source to destination storage bin
General warehouse	Relocations: Suggestions from the System	Better use of storage space
General warehouse	Relocations: Suggestions from the System	Consistent use of storage areas
General warehouse	Relocations: Suggestions from the System	Rearrangement in the correct ABC zone
General warehouse	Relocations: Suggestions from the System	The creation of open space by combining the same items in partial quantities in a storage bin
General warehouse	Replenishment	Managing a minimum and maximum inventory per item for the picking
General warehouse	Reservations for Delivery Orders	Reservation of the orders by customer priority, orders and / or delivery
General warehouse	Reservations for Delivery Orders	Reservation of the orders by the sequence
General warehouse	Resource Planning	Determination of the total processing time of a task
General warehouse	Resource Planning	Determine the starting time of a task
General warehouse	Resource Planning	Employee-related resource planning (ie, information about usage, orders, necessary staff and existing staff in the system can be deposited)
General warehouse	Resource Planning	Employee-related resources planning, taking into account the standard time
General warehouse	Resource Planning	Notification of deviations in actual and processing times
General warehouse	Resource Planning	Taking into account the qualifications, hours of work allowed, activities and range of staff in resource planning
General warehouse	Resource Planning	Update of the standard time based on the activities carried out
General warehouse	Resource Planning	Update of the standard time based on the activities carried out
General warehouse	Retrieval	FEFO
General warehouse	Retrieval	FIFO
General warehouse	Retrieval	Outsourcing by the amount
General warehouse	Returns	Management of returned goods (reason)
General warehouse	Returns	Processing of returns with respect to originally Order
General warehouse	Returns	Receipt of goods as normal goods received (if possible)
General warehouse	Serial Number Handling	Continuous reference of serial number according to the customer
General warehouse	Serial Number Handling	Continuous-reference the serial number ranges to the customer
General warehouse	Serial Number Handling	Enter serial number ranges
General warehouse	Serial Number Handling	Serial numbers is available
General warehouse	Shipping units management	Dimensions
General warehouse	Shipping units management	Gross weight
General warehouse	Shipping units management	Sales order number
General warehouse	Standard Forms / Printouts	Additional loading lists by shipping units
General warehouse	Standard Forms / Printouts	Address labels for shipping
General warehouse	Standard Forms / Printouts	Delivery notices
General warehouse	Standard Forms / Printouts	Detailed list of the warehouse services that took place (for example, rent, type of service)
General warehouse	Standard Forms / Printouts	Goods receipt confirmation
General warehouse	Standard Forms / Printouts	Invoice for warehouse services
General warehouse	Standard Forms / Printouts	Invoice on behalf of the customer
General warehouse	Standard Forms / Printouts	Loading lists
General warehouse	Standard Forms / Printouts	Order-picking lists
General warehouse	Standard Forms / Printouts	Shipping labels for transport system (for example, Mistral)
General warehouse	Standard Forms / Printouts	Storage list
General warehouse	Standard Forms / Printouts	Warehousing labels
General warehouse	Standard Forms / Printouts	Waybill
General warehouse	Storage Place Information	Bin location depth
General warehouse	Storage Place Information	Bin location height
General warehouse	Storage Place Information	Bin location width (storage location)
General warehouse	Storage Place Information	Block indicator
General warehouse	Storage Place Information	Capacity: variable quantity of different storage units per storage location
General warehouse	Storage Place Information	Storage unit management: different items in a storage unit
General warehouse	Storage Place Information	Storage unit management: different packaging sizes of the same article on a storage unit
General warehouse	Transaction Logging	Storing the amount in the stock movement log
General warehouse	Transaction Logging	Storing the batch in the stock movement log
General warehouse	Transaction Logging	Storing the date of entry and exit in the stock movement log
General warehouse	Transaction Logging	Storing the goods movement type in the stock movement log
General warehouse	Transaction Logging	Storing the item number in the stock movement log

Category A features

General warehouse	Transaction Logging	Storing the job reference in the stock movement log
General warehouse	Transaction Logging	Storing the serial number in the stock movement log
General warehouse	Transaction Logging	Storing the storage / shipping container in the stock movement log
General warehouse	Transaction Logging	Storing the storage bin in the stock movement log
General warehouse	Types of Inventory	Available / free stock
General warehouse	Types of Inventory	Blocked stock
General warehouse	Types of Inventory	Mature stock
General warehouse	Types of Inventory	Order point
General warehouse	Types of Inventory	Reporting, minimum, safety stock
General warehouse	Types of Inventory	Reserved stock
General warehouse	Types of Inventory	Scrapping stock
General warehouse	Types of Inventory	Total stock
General warehouse	Units of Measure	Conversion of a unit in another
General warehouse	Units of Measure	Units per length, height, width
General warehouse	Units of Measure	Units per volume
General warehouse	Units of Measure	Units per weight
General warehouse	Warehouse Control	Assignment of articles on picking dynamic (not fixed assignment)
General warehouse	Warehouse Control	Assignment of articles on picking partially static, partially dynamic (eg dependent on the ABC classification)
General warehouse	Warehouse Control	Assignment of articles on picking static hard to place system
Internal	Alert Functions	Alarm at the impending overrun of BBD
Internal	Blocking	Blocked by BBD (Best before date)
Internal	Comparison of ASN and Goods Receipt	goods received - (Individual confirmation of each item)
Internal	Invoicing / Billing of Warehouse Services	Deposit of prices for services
Internal	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the article
Internal	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the customer
Internal	Loading	Check the correct loading by manual entry of a check digit
Internal	Loading	Check the correct loading of the check digit by scanning
Internal	Master Data Clients, Customers, Suppliers	Billing Address
Internal	Master Data Clients, Customers, Suppliers	Classifications (eg, payment behavior, delivery reliability, ...)
Internal	Master Data Clients, Customers, Suppliers	Conditions / prices
Internal	Master Data Clients, Customers, Suppliers	Invoicing in favor of customer
Internal	Multiple Warehouses	Manual distribution of an order to multiple warehouses
Internal	Picking	Acquisition of picking orders from external application
Internal	Picking	Dynamic pick optimization
Internal	Picking Methods	Picking waves
Internal	Picking Strategies	Inventory rotation methods (FIFO, FEFO, etc)
Internal	Transaction Logging	reason for goods received / goods issue (supply, return, ...)
Internal	Transport Devices	Path optimization within a transfer order

Category B features

Business area	WMS Function	Feature
Automotive	Alert Functions	Alarm at the impending overrun of BBD
Automotive	Assembly	Automatic generation of picking and transport contracts for the components of a finished product / item according to the parts list
Automotive	Assembly	Automatic stock transfer after confirmation of the assembly and disassembly operations
Automotive	Assembly	Management of batch numbers of used components for the end product or the item
Automotive	Blocking	Blocked by BBD (Best before date)
Automotive	Blocking	Blocked by product
Automotive	Building of Shipping Units	Consideration of co-pack bans for the formation of shipping units
Automotive	Building of Shipping Units	Consideration of packaging rules for the formation of Shipping Units
Automotive	Building of Shipping Units	Exact allocation of items and quantities on the loading equipment (including shipping mixed units) (proposal for picking)
Automotive	Building of Shipping Units	Formation of shipping units to the loading equipment-specific requirements (eg, weight limit)
Automotive	Building of Shipping Units	Generation of packing patterns
Automotive	Comparison of ASN and Goods Receipt	goods received - (Partial confirmation of the advance shipping note for the respective partial delivery)
Automotive	Comparison of ASN and Goods Receipt	goods received - (Individual confirmation of each item)
Automotive	Comparison of ASN and Goods Receipt	goods received - confirmation by confirming the full payment advices (Confirmation of the complete advanced shipping note)
Automotive	Customs	Intrastat - Login
Automotive	Empties Handling	Cause of empties and Loading Equipment accounts per customer
Automotive	Goods Issue	Generation of SSCC (Serial Shipment Container Code)
Automotive	Goods Issue	Support the multi-level management of SSCC (for example which SSCC have the pallets in the container at a predetermined SSCC)
Automotive	Goods Receipt	best-before date (BBD)
Automotive	Goods Receipt	Deposit of item-specific work instructions like packaging instuctions
Automotive	Goods Receipt	Packaging scheme used
Automotive	Goods Receipt	Platform
Automotive	Goods Receipt	Serial number
Automotive	Information on Shipping Units	Classification
Automotive	Information on Shipping Units	Content declaration (content of the shipping unit)
Automotive	Inventory Management	Generation of orders for various methods
Automotive	Inventory Process	Different points in time inventory for each client
Automotive	Inventory Process	Interfaces to the acquisition of external requirements for inventory
Automotive	Invoicing / Billing of Warehouse Services	Deposit of prices for services
Automotive	Invoicing / Billing of Warehouse Services	Deposit of tiered pricing for services
Automotive	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by batch
Automotive	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per client
Automotive	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer
Automotive	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer order
Automotive	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per item
Automotive	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from client
Automotive	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the article
Automotive	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the customer
Automotive	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Automotive	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Automotive	Invoicing / Billing of Warehouse Services	Product or order type based invoicing depending on client's business area
Automotive	Item Master Data	Category / Product Group
Automotive	Item Master Data	Currency
Automotive	Item Master Data	Customs tariff number (code)
Automotive	Item Master Data	Supplier item number
Automotive	Item Master Data	Value
Automotive	Multiple Clients	Storage of the stock of different clients in a storage bin
Automotive	Multiple Warehouses	Automatic distribution of an order to multiple warehouses

Category B features

Automotive	Multiple Warehouses	Automatic distribution of individual order items at multiple warehouses
Automotive	Multiple Warehouses	Manual distribution of an order to multiple warehouses
Automotive	Multiple Warehouses	Manual distribution of individual order items at multiple warehouses
Automotive	Multiple Warehouses	Procurement of supplies between two warehouses
Automotive	Order Priority	Automatic time-dependent increase in the priority
Automotive	Picking	Acquisition of picking orders from external application
Automotive	Picking	Dynamic pick optimization
Automotive	Picking Strategies	Inventory rotation methods (FIFO, FEFO, etc)
Automotive	Picking Strategies	Product pick order generation (discreet, linear, item load)
Automotive	Printing Functions in Outbound	Production of goods issue papers depending on other criteria (such as sales, shipping, carrier ...)
Automotive	Production Supply	At expiration of validity: automatic choice of substitution item at next call-off for expired item
Automotive	Production Supply	At expiration of validity: expired item is automatically blocked for picking
Automotive	Production Supply	At expiration of validity: warning message at next call-off for expired item
Automotive	Production Supply	Combination of delivery orders in one delivery to the production line (route planning)
Automotive	Production Supply	Manual change of route planning
Automotive	Production Supply	Registration of substitution item for item with limited validity
Automotive	Production Supply	Report of all expired items
Automotive	Production Supply	Validity period per item
Automotive	Production Supply	Validity period per item and point of use
Automotive	Put-away	Support the placement strategy after charge storage
Automotive	Put-away	Support the placement strategy after dangerous classes
Automotive	Put-away	Support the placement strategy after Single item
Automotive	Storage Place Information	Storage conditions for each product group
Automotive	Storage Place Information	Storage conditions for each storage zone
Automotive	Storage Place Information	Weights for each storage location
Automotive	Transaction Logging	reason for goods received / goods issue (supply, return, ...)
Automotive	Transport Devices	Management of information about transportation, such as type, max. Load / capacity, range of application, allowed items / load support, performance indicators etc.
Automotive	Transport Devices	Transport management is available
Automotive	Units of Measure	Create additional units possible
Consumer / FMCG	Alert Functions	Alarm at the impending overrun of BBD
Consumer / FMCG	Assembly	Automatic generation of picking and transport contracts for the components of a finished product / item according to the parts list
Consumer / FMCG	Assembly	Management of batch numbers of used components for the end product or the item
Consumer / FMCG	Building of Shipping Units	Calculating the number of required loading aids in the formation of shipping units
Consumer / FMCG	Building of Shipping Units	Consideration of co-pack bans for the formation of shipping units
Consumer / FMCG	Building of Shipping Units	Consideration of packaging rules for the formation of Shipping Units
Consumer / FMCG	Building of Shipping Units	Exact allocation of items and quantities on the loading equipment (including shipping mixed units) (proposal for picking)
Consumer / FMCG	Building of Shipping Units	Formation of shipping units to the loading equipment-specific requirements (eg, weight limit)
Consumer / FMCG	Building of Shipping Units	Generation of packing patterns
Consumer / FMCG	Comparison of ASN and Goods Receipt	goods received - (Partial confirmation of the advance shipping note for the respective partial delivery)
Consumer / FMCG	Comparison of ASN and Goods Receipt	goods received - (Individual confirmation of each item)
Consumer / FMCG	Comparison of ASN and Goods Receipt	goods received - confirmation by confirming the full payment advices (Confirmation of the complete advanced shipping note)
Consumer / FMCG	Customs	Intrastat - Login
Consumer / FMCG	Data Exchange with other Systems	Outward stock movement data
Consumer / FMCG	Delivery Orders	Automatic conversion of units of the order item in stock customary units
Consumer / FMCG	Dock & Yard Management	Deposit of targeted delivery times (inwards)
Consumer / FMCG	Empties Handling	Cause of empties and Loading Equipment accounts per customer

Category B features

Consumer / FMCG	Goods Issue	Generation of SSCC (Serial Shipment Container Code)
Consumer / FMCG	Goods Issue	Support the multi-level management of SSCC (for example which SSCC have the pallets in the container at a predetermined SSCC)
Consumer / FMCG	Goods Receipt	Deposit of item-specific work instructions like packaging instuctions
Consumer / FMCG	Goods Receipt	Packaging scheme used
Consumer / FMCG	Goods Receipt	Platform
Consumer / FMCG	Goods Receipt	Serial number
Consumer / FMCG	Inbound Preadvice (ASN)	best-before date (BBD)
Consumer / FMCG	Information on Shipping Units	Classification
Consumer / FMCG	Information on Shipping Units	Content declaration (content of the shipping unit)
Consumer / FMCG	Inventory Management	Generation of orders for various methods
Consumer / FMCG	Inventory Process	Different points in time inventory for each client
Consumer / FMCG	Inventory Process	Interfaces to the acquisition of external requirements for inventory
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Deposit of prices for services
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Deposit of tiered pricing for services
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by batch
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per client
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer order
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per item
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from client
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the article
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the customer
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Product or order type based invoicing depending on client's business area
Consumer / FMCG	Item Master Data	Category / Product Group
Consumer / FMCG	Item Master Data	Currency
Consumer / FMCG	Item Master Data	Customs tariff number (code)
Consumer / FMCG	Item Master Data	Supplier item number
Consumer / FMCG	Item Master Data	Value
Consumer / FMCG	Loading	Check the correct loading by manual entry of a check digit
Consumer / FMCG	Loading	Check the correct loading of the check digit by scanning
Consumer / FMCG	Master Data Clients, Customers, Suppliers	Billing Address
Consumer / FMCG	Master Data Clients, Customers, Suppliers	Classifications (eg, payment behavior, delivery reliability, ...)
Consumer / FMCG	Master Data Clients, Customers, Suppliers	Conditions / prices
Consumer / FMCG	Master Data Clients, Customers, Suppliers	Credit line
Consumer / FMCG	Master Data Clients, Customers, Suppliers	Invoicing in favor of customer
Consumer / FMCG	Multiple Clients	Storage of the stock of different clients in a storage bin
Consumer / FMCG	Multiple Warehouses	Automatic distribution of an order to multiple warehouses
Consumer / FMCG	Multiple Warehouses	Automatic distribution of individual order items at multiple warehouses
Consumer / FMCG	Multiple Warehouses	Manual distribution of an order to multiple warehouses
Consumer / FMCG	Multiple Warehouses	Manual distribution of individual order items at multiple warehouses
Consumer / FMCG	Multiple Warehouses	Procurement of supplies between two warehouses
Consumer / FMCG	Order Priority	Automatic time-dependent increase in the priority
Consumer / FMCG	Picking	Acquisition of picking orders from external application
Consumer / FMCG	Picking	Dynamic pick optimization
Consumer / FMCG	Picking Methods	Negative-picking
Consumer / FMCG	Picking Methods	Picking waves
Consumer / FMCG	Picking Strategies	Inventory rotation methods (FIFO, FEFO, etc)
Consumer / FMCG	Picking Strategies	Product pick order generation (discreet, linear, item load)
Consumer / FMCG	Printing Functions in Outbound	Production of goods issue papers depending on other criteria (such as sales, shipping, carrier ...)
Consumer / FMCG	Production Supply	At expiration of validity: automatic choice of substitution item at next call-off for expired item
Consumer / FMCG	Production Supply	At expiration of validity: expired item is automatically blocked for picking
Consumer / FMCG	Production Supply	At expiration of validity: warning message at next call-off for expired item

Category B features

Consumer / FMCG	Production Supply	Combination of delivery orders in one delivery to the production line (route planning)
Consumer / FMCG	Production Supply	Manual change of route planning
Consumer / FMCG	Production Supply	Registration of substitution item for item with limited validity
Consumer / FMCG	Production Supply	Report of all expired items
Consumer / FMCG	Production Supply	Validity period per item
Consumer / FMCG	Production Supply	Validity period per item and point of use
Consumer / FMCG	Put-away	Support the placement strategy after charge storage
Consumer / FMCG	Put-away	Support the placement strategy after dangerous classes
Consumer / FMCG	Put-away	Support the placement strategy after Single item
Consumer / FMCG	Relocations: Suggestions from the System	The creation of open space by aggregation of a different article at a storage place
Consumer / FMCG	Replenishment	Automatic request of filling up of a commission area
Consumer / FMCG	Resource Planning	Transportation-related resources planning taking into account the standard time
Consumer / FMCG	Shipping	Manual handling equipment selection for a tour
Consumer / FMCG	Storage Place Information	Storage conditions for each product group
Consumer / FMCG	Storage Place Information	Storage conditions for each storage zone
Consumer / FMCG	Storage Place Information	Weights for each storage location
Consumer / FMCG	Transaction Logging	reason for goods received / goods issue (supply, return, ...)
Consumer / FMCG	Transport Devices	Management of information about transportation, such as type, max. Load / capacity, range of application, allowed items / load support, performance indicators etc.
Consumer / FMCG	Transport Devices	Sequence optimization over several orders
Consumer / FMCG	Transport Devices	Transport management is available
Consumer / FMCG	Units of Measure	Create additional units possible
General warehouse	Alert Functions	Alarms if stock falls below the minimum stock
General warehouse	Alert Functions	Alarms if there is timeout in order processing
General warehouse	Assembly	Automatic generation of work orders, if the finished product or the item is no longer sufficient available
General warehouse	Assembly	Deposit-stage BOMs
General warehouse	Assembly	Management of the serial numbers of the components used for the finished product or the product
General warehouse	Assembly	Manual entry of assembly and disassembly jobs
General warehouse	Availability Check for Delivery Orders	Availability check from the free / available stock
General warehouse	Batch Number Handling	Continuous reference of the batches to the customer
General warehouse	Batch Number Handling	Continuous tracking of batches by the supplier
General warehouse	Blocking	Blocked by serial number
General warehouse	Blocking	Lock-free defined storage areas / storage areas
General warehouse	Building of Shipping Units	Formation of shipping units after job-specific requirements
General warehouse	Cancelling Functions	Cancellation of the GI posting
General warehouse	Cancelling Functions	Cancellation of the GR posting
General warehouse	Cancelling Functions	Cancellation of transfer orders
General warehouse	Comparison of ASN and Goods Receipt	Best before date (BBD)
General warehouse	Comparison of ASN and Goods Receipt	Country of origin
General warehouse	Comparison of ASN and Goods Receipt	Goods received - confirmation to the supplier via EDI
General warehouse	Correction Bookings	Support for adjustment postings by change in the quality status
General warehouse	Correction Bookings	Support for adjustment postings by modification of the BBD
General warehouse	Data Exchange with other Systems	Inward stock movement data
General warehouse	Data Exchange with other Systems	Labeling system
General warehouse	Data Exchange with other Systems	Weighing System
General warehouse	Delivery Orders	Automatic plausibility check by the system, such as minimum order size, unusually high order volume, unusual items ...
General warehouse	Empties Handling	Unambiguous (clear) identification of the loading aids
General warehouse	Goods Issue	Recording the batch number in goods issue
General warehouse	Goods Issue	Recording the serial number in goods issue
General warehouse	Goods Issue	Tour-related shipment / order combination
General warehouse	Goods Receipt	Acquisition of goods receipt by the detection of each package
General warehouse	Inbound Preadvice (ASN)	Packaging scheme used
General warehouse	Inventory / Stocktaking	Near-zero inventory
General warehouse	Inventory Management	Maturation / quarantine
General warehouse	Inventory Process	Basic inventory of unit loads
General warehouse	Inventory Process	Different time points for each inventory storage area
General warehouse	Inventory Process	Different types of inventory for different items
General warehouse	Inventory Process	Inventory of the previous day inputs

Category B features

General warehouse	Item Master Data	Joint storage ban
General warehouse	KPI's	Determine the workload as a combination of the above criteria
General warehouse	KPI's	Determine the workload per bearing zone
General warehouse	KPI's	Evaluation of shelf-life as a combination of item / customer (an article or more)
General warehouse	KPI's	Evaluation of storage time per item
General warehouse	KPI's	KPI à delivery volume accuracy
General warehouse	KPI's	KPI à list of items with inventory deficit
General warehouse	KPI's	KPI à Stock Overview over time
General warehouse	KPI's	Query on the deviation of the supplier quality target-sets
General warehouse	KPI's	Query the supplier quality on the quality of delivery
General warehouse	KPI's	Query tracking events dep. from customer order
General warehouse	KPI's	Query tracking events dep. from supplier
General warehouse	KPI's	Query tracking events dep. of article
General warehouse	KPI's	Query tracking events dep. of the charge
General warehouse	KPI's	Query tracking events dep. the customer
General warehouse	Label Printing at Goods Receipt	Deposit of different label layouts
General warehouse	Labeling	Query made by labeling
General warehouse	Multiple Clients	Transfer of resources from one client to another client
General warehouse	Multiple Warehouses	Allocation of an article to a warehouse
General warehouse	Multiple Warehouses	Multi-warehouse system
General warehouse	Order Release	Automated order release for route planning
General warehouse	Order Release	Automatic order release scheduled (eg, JIT)
General warehouse	Pick Check	Bin control
General warehouse	Picking Methods	Two-stage picking
General warehouse	Picking Order	Information providing means for picking with Pick to Voice
General warehouse	Picking Sequence	Availability check immediately prior to the release of the picking
General warehouse	Picking Sequence	Support of the loop path optimization strategy
General warehouse	Picking Sequence	Support of the random response strategy for path optimization
General warehouse	Put-away	Automatic determination of an alternative storage location for storage
General warehouse	Put-away	Support the placement strategy after filling level of the storage areas (eg, 3 IP, or 2 EP)
General warehouse	Put-away	Support the placement strategy after temperature classes
General warehouse	Put-away	Support the placement strategy after utilization even usage of storage areas such as aisles
General warehouse	Queries / Reports	Save the report as ASCII file
General warehouse	Relocations	Direct rearrangement from goods received to the picking
General warehouse	Relocations	Direct rearrangement from goods received to the supply area
General warehouse	Repacking	Consideration of various requirements of repackaging (eg, Article, client, customer ...)
General warehouse	Repacking	Deposit of standard times for the repackaging
General warehouse	Repacking	Different instructions to various criteria, eg per item, client, customer ...
General warehouse	Repacking	Query used materials for repackaging
General warehouse	Repacking	Storing the actual time required for the repackaging
General warehouse	Repacking	Support for supplies needed for carrier / packing material
General warehouse	Repacking	Update of the standard time for repacking the basis of the activities
General warehouse	Replenishment	Managing a minimum and maximum inventory per item for the supply or spare area
General warehouse	Replenishment	Multi-level replenishment strategy
General warehouse	Retrieval	Outsourcing by customer-dependent residual life
General warehouse	Retrieval	Outsourcing by production date
General warehouse	Retrieval	Support manual removal strategy
General warehouse	Serial Number Handling	Continuous tracking of serial numbers according to the supplier
General warehouse	Serial Number Handling	Continuous tracking of the serial number range for the supplier
General warehouse	Shipping units management	Displaying the shipping units belonging to a specific customer order
General warehouse	Shipping units management	Displaying the shipping units belonging to a specific shipment
General warehouse	Shipping units management	Loading
General warehouse	Shipping units management	Stacking
General warehouse	Standard Forms / Printouts	Customs form T1 (goods issue)
General warehouse	Standard Forms / Printouts	Goods issue confirmation

Category B features

General warehouse	Storage Place Information	Capacity: fixed quantity of the same storage unit per storage location (bin location)
General warehouse	Storage Place Information	Permissible loading aids
General warehouse	Types of Inventory	Quality control stock
High-tech	Alert Functions	Alarm at the impending overrun of BBD
High-tech	Assembly	Automatic generation of picking and transport contracts for the components of a finished product / item according to the parts list
High-tech	Assembly	Automatic stock transfer after confirmation of the assembly and disassembly operations
High-tech	Assembly	Management of batch numbers of used components for the end product or the item
High-tech	Blocking	Blocked by product
High-tech	Building of Shipping Units	Consideration of co-pack bans for the formation of shipping units
High-tech	Building of Shipping Units	Consideration of packaging rules for the formation of Shipping Units
High-tech	Building of Shipping Units	Exact allocation of items and quantities on the loading equipment (including shipping mixed units) (proposal for picking)
High-tech	Building of Shipping Units	Formation of shipping units to the loading equipment-specific requirements (eg, weight limit)
High-tech	Building of Shipping Units	Generation of packing patterns
High-tech	Comparison of ASN and Goods Receipt	goods received - (Partial confirmation of the advance shipping note for the respective partial delivery)
High-tech	Comparison of ASN and Goods Receipt	goods received - (Individual confirmation of each item)
High-tech	Comparison of ASN and Goods Receipt	goods received - confirmation by confirming the full payment advices (Confirmation of the complete advanced shipping note)
High-tech	Customs	Intrastat - Login
High-tech	Empties Handling	Cause of empties and Loading Equipment accounts per customer
High-tech	Goods Issue	Generation of SSCC (Serial Shipment Container Code)
High-tech	Goods Issue	Support the multi-level management of SSCC (for example which SSCC have the pallets in the container at a predetermined SSCC)
High-tech	Goods Receipt	best-before date (BBD)
High-tech	Goods Receipt	Deposit of item-specific work instructions like packaging instuctions
High-tech	Goods Receipt	Packaging scheme used
High-tech	Goods Receipt	Platform
High-tech	Goods Receipt	Serial number
High-tech	Information on Shipping Units	Classification
High-tech	Information on Shipping Units	Content declaration (content of the shipping unit)
High-tech	Inventory Management	Generation of orders for various methods
High-tech	Inventory Process	Different points in time inventory for each client
High-tech	Inventory Process	Interfaces to the acquisition of external requirements for inventory
High-tech	Invoicing / Billing of Warehouse Services	Deposit of tiered pricing for services
High-tech	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by batch
High-tech	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per client
High-tech	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer
High-tech	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer order
High-tech	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per item
High-tech	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from client
High-tech	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the article
High-tech	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the customer
High-tech	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
High-tech	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
High-tech	Invoicing / Billing of Warehouse Services	Product or order type based invoicing depending on client's business area
High-tech	Item Master Data	Category / Product Group
High-tech	Item Master Data	Currency
High-tech	Item Master Data	Customs tariff number (code)
High-tech	Item Master Data	Supplier item number
High-tech	Item Master Data	Value
High-tech	Master Data Clients, Customers, Suppliers	Billing Address

Category B features

High-tech	Master Data Clients, Customers, Suppliers	Classifications (eg, payment behavior, delivery reliability, ...)
High-tech	Master Data Clients, Customers, Suppliers	Conditions / prices
High-tech	Master Data Clients, Customers, Suppliers	Credit line
High-tech	Master Data Clients, Customers, Suppliers	Invoicing in favor of customer
High-tech	Multiple Warehouses	Automatic distribution of an order to multiple warehouses
High-tech	Multiple Warehouses	Automatic distribution of individual order items at multiple warehouses
High-tech	Multiple Warehouses	Manual distribution of an order to multiple warehouses
High-tech	Multiple Warehouses	Manual distribution of individual order items at multiple warehouses
High-tech	Multiple Warehouses	Procurement of supplies between two warehouses
High-tech	Order Priority	Automatic time-dependent increase in the priority
High-tech	Order Release	Backorder management
High-tech	Picking	Acquisition of picking orders from external application
High-tech	Picking	Dynamic pick optimization
High-tech	Picking Methods	Negative-picking
High-tech	Picking Strategies	Inventory rotation methods (FIFO, FEFO, etc)
High-tech	Picking Strategies	Product pick order generation (discreet, linear, item load)
High-tech	Production Supply	At expiration of validity: automatic choice of substitution item at next call-off for expired item
High-tech	Production Supply	At expiration of validity: expired item is automatically blocked for picking
High-tech	Production Supply	At expiration of validity: warning message at next call-off for expired item
High-tech	Production Supply	Combination of delivery orders in one delivery to the production line (route planning)
High-tech	Production Supply	Manual change of route planning
High-tech	Production Supply	Registration of substitution item for item with limited validity
High-tech	Production Supply	Report of all expired items
High-tech	Production Supply	Validity period per item
High-tech	Production Supply	Validity period per item and point of use
High-tech	Put-away	Support the placement strategy after dangerous classes
High-tech	Put-away	Support the placement strategy after Single item
High-tech	Relocations: Suggestions from the System	The creation of open space by aggregation of a different article at a storage place
High-tech	Resource Planning	Transportation-related resources planning taking into account the standard time
High-tech	Storage Place Information	Storage conditions for each product group
High-tech	Storage Place Information	Storage conditions for each storage zone
High-tech	Storage Place Information	Weights for each storage location
High-tech	Transaction Logging	reason for goods received / goods issue (supply, return, ...)
High-tech	Transport Devices	Management of information about transportation, such as type, max. Load / capacity, range of application, allowed items / load support, performance indicators etc.
High-tech	Transport Devices	Sequence optimization over several orders
High-tech	Transport Devices	Transport management is available
High-tech	Types of Inventory	In transit in procurement
High-tech	Units of Measure	Create additional units possible
Industrial	Alert Functions	Alarm at the impending overrun of BBD
Industrial	Assembly	Automatic generation of picking and transport contracts for the components of a finished product / item according to the parts list
Industrial	Assembly	Automatic stock transfer after confirmation of the assembly and disassembly operations
Industrial	Assembly	Management of batch numbers of used components for the end product or the item
Industrial	Blocking	Blocked by BBD (Best before date)
Industrial	Blocking	Blocked by product
Industrial	Building of Shipping Units	Consideration of co-pack bans for the formation of shipping units
Industrial	Building of Shipping Units	Consideration of packaging rules for the formation of Shipping Units
Industrial	Building of Shipping Units	Exact allocation of items and quantities on the loading equipment (including shipping mixed units) (proposal for picking)
Industrial	Building of Shipping Units	Formation of shipping units to the loading equipment-specific requirements (eg, weight limit)
Industrial	Building of Shipping Units	Generation of packing patterns

Category B features

Industrial	Comparison of ASN and Goods Receipt	goods received - (Partial confirmation of the advance shipping note for the respective partial delivery)
Industrial	Comparison of ASN and Goods Receipt	goods received - (Individual confirmation of each item)
Industrial	Comparison of ASN and Goods Receipt	goods received - confirmation by confirming the full payment advices (Confirmation of the complete advanced shipping note)
Industrial	Customs	Intrastat - Login
Industrial	Empties Handling	Cause of empties and Loading Equipment accounts per customer
Industrial	Goods Issue	Generation of SSCC (Serial Shipment Container Code)
Industrial	Goods Issue	Support the multi-level management of SSCC (for example which SSCC have the pallets in the container at a predetermined SSCC)
Industrial	Goods Receipt	best-before date (BBD)
Industrial	Goods Receipt	Deposit of item-specific work instructions like packaging instuctions
Industrial	Goods Receipt	Packaging scheme used
Industrial	Goods Receipt	Platform
Industrial	Goods Receipt	Serial number
Industrial	Inbound Preadvice (ASN)	best-before date (BBD)
Industrial	Information on Shipping Units	Classification
Industrial	Information on Shipping Units	Content declaration (content of the shipping unit)
Industrial	Inventory Management	Generation of orders for various methods
Industrial	Inventory Process	Interfaces to the acquisition of external requirements for inventory
Industrial	Invoicing / Billing of Warehouse Services	Deposit of prices for services
Industrial	Invoicing / Billing of Warehouse Services	Deposit of tiered pricing for services
Industrial	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by batch
Industrial	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per client
Industrial	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer
Industrial	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer order
Industrial	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per item
Industrial	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from client
Industrial	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the article
Industrial	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of the customer
Industrial	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Industrial	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Industrial	Invoicing / Billing of Warehouse Services	Product or order type based invoicing depending on client's business area
Industrial	Item Master Data	Category / Product Group
Industrial	Item Master Data	Currency
Industrial	Item Master Data	Customs tariff number (code)
Industrial	Item Master Data	Multi-level BOM (bill of materials)
Industrial	Item Master Data	Supplier item number
Industrial	Item Master Data	Value
Industrial	Master Data Clients, Customers, Suppliers	Billing Address
Industrial	Master Data Clients, Customers, Suppliers	Classifications (eg, payment behavior, delivery reliability, ...)
Industrial	Master Data Clients, Customers, Suppliers	Conditions / prices
Industrial	Master Data Clients, Customers, Suppliers	Credit line
Industrial	Master Data Clients, Customers, Suppliers	Invoicing in favor of customer
Industrial	Multiple Warehouses	Automatic distribution of an order to multiple warehouses
Industrial	Multiple Warehouses	Automatic distribution of individual order items at multiple warehouses
Industrial	Multiple Warehouses	Manual distribution of an order to multiple warehouses
Industrial	Multiple Warehouses	Manual distribution of individual order items at multiple warehouses
Industrial	Multiple Warehouses	Procurement of supplies between two warehouses
Industrial	Order Priority	Automatic time-dependent increase in the priority
Industrial	Order Release	Backorder management
Industrial	Picking	Acquisition of picking orders from external application
Industrial	Picking	Dynamic pick optimization
Industrial	Picking Methods	Negative-picking
Industrial	Picking Strategies	Inventory rotation methods (FIFO, FEFO, etc)
Industrial	Picking Strategies	Product pick order generation (discreet, linear, item load)

Category B features

Industrial	Printing Functions in Outbound	Production of goods issue papers depending on other criteria (such as sales, shipping, carrier ...)
Industrial	Production Supply	At expiration of validity: automatic choice of substitution item at next call-off for expired item
Industrial	Production Supply	At expiration of validity: expired item is automatically blocked for picking
Industrial	Production Supply	At expiration of validity: warning message at next call-off for expired item
Industrial	Production Supply	Combination of delivery orders in one delivery to the production line (route planning)
Industrial	Production Supply	Manual change of route planning
Industrial	Production Supply	Registration of substitution item for item with limited validity
Industrial	Production Supply	Report of all expired items
Industrial	Production Supply	Validity period per item
Industrial	Production Supply	Validity period per item and point of use
Industrial	Put-away	Support the placement strategy after charge storage
Industrial	Put-away	Support the placement strategy after Single item
Industrial	Relocations: Suggestions from the System	The creation of open space by aggregation of a different article at a storage place
Industrial	Sequencing	Booking of goods issue for complete delivery (all parts on the rack)
Industrial	Sequencing	Management of the sequence of parts in a special rack delivered to the production line
Industrial	Sequencing	Picker gets information on mobile terminal about position of the part on the rack.
Industrial	Storage Place Information	Storage conditions for each product group
Industrial	Storage Place Information	Storage conditions for each storage zone
Industrial	Storage Place Information	Weights for each storage location
Industrial	Transaction Logging	reason for goods received / goods issue (supply, return, ...)
Industrial	Transport Devices	Management of information about transportation, such as type, max. Load / capacity, range of application, allowed items / load support, performance indicators etc.
Industrial	Transport Devices	Transport management is available
Industrial	Types of Inventory	In transit in procurement
Industrial	Units of Measure	Create additional units possible
Internal	Assembly	Automatic generation of picking and transport contracts for the components of a finished product / item according to the parts list
Internal	Assembly	Automatic stock transfer after confirmation of the assembly and disassembly operations
Internal	Assembly	Deposit of a batch size of finished products / articles
Internal	Assembly	Deposit of assembly instructions to various criteria, eg client, customer, order ...
Internal	Assembly	Deposit of standard times for the assembly operation
Internal	Assembly	Generation of transport requests for re-storage of the finished product / item
Internal	Assembly	Management of batch numbers of used components for the end product or the item
Internal	Assembly	Stepwise viewing of assembly instructions
Internal	Assembly	Storing the actual time needed for assembly
Internal	Assembly	Two-stage deposit bills
Internal	Assembly	View the assembly instructions
Internal	Availability Check for Delivery Orders	Availability check in the light of duty-unpaid stock
Internal	Blocking	Blocked by product
Internal	Blocking	Blocked by serial number range
Internal	Blocking	Blocked by SSCC (Serial shipping container code)
Internal	Building of Shipping Units	Consideration of co-pack bans for the formation of shipping units
Internal	Building of Shipping Units	Consideration of packaging rules for the formation of Shipping Units
Internal	Building of Shipping Units	Exact allocation of items and quantities on the loading equipment (including shipping mixed units) (proposal for picking)
Internal	Building of Shipping Units	Generation of packing patterns
Internal	Building of Shipping Units	Packaging management concerning different types of pallets
Internal	Building of Shipping Units	Packaging management concerning different types of rolling cages
Internal	Comparison of ASN and Goods Receipt	goods received - (Partial confirmation of the advance shipping note for the respective partial delivery)

Category B features

Internal	Comparison of ASN and Goods Receipt	goods received - confirmation by confirming the full payment advices (Confirmation of the complete advanced shipping note)
Internal	Correction Bookings	Support for adjustment postings according to change in the batch number
Internal	Customs	Intrastat - Login
Internal	Data Exchange with other Systems	Outward stock movement data
Internal	Data Exchange with other Systems	Transport System
Internal	Delivery Orders	Automatic conversion of units of the order item in stock customary units
Internal	Dock & Yard Management	Deposit of targeted delivery times (inwards)
Internal	Dock & Yard Management	Deposit of delivery target times (outwards)
Internal	Dock & Yard Management	Manual assignment of a truck at a dock
Internal	Goods Issue	Generation of SSCC (Serial Shipment Container Code)
Internal	Goods Issue	Support for controlling freight costs
Internal	Goods Issue	Support the multi-level management of SSCC (for example which SSCC have the pallets in the container at a predetermined SSCC)
Internal	Goods Receipt	best-before date (BBD)
Internal	Goods Receipt	Deposit of item-specific work instructions like packaging instuctions
Internal	Goods Receipt	Packaging scheme used
Internal	Goods Receipt	Platform
Internal	Goods Receipt	Serial number
Internal	Inbound Preadvice (ASN)	best-before date (BBD)
Internal	Information on Shipping Units	Classification
Internal	Information on Shipping Units	Content declaration (content of the shipping unit)
Internal	Inventory Process	Interfaces to the acquisition of external requirements for inventory
Internal	Invoicing / Billing of Warehouse Services	Deposit of tiered pricing for services
Internal	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by batch
Internal	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per client
Internal	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer
Internal	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per customer order
Internal	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided per item
Internal	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from client
Internal	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Internal	Invoicing / Billing of Warehouse Services	Generation of invoices for services rendered per client
Internal	Invoicing / Billing of Warehouse Services	Product or order type based invoicing depending on client's business area
Internal	Item Master Data	Category / Product Group
Internal	Item Master Data	Currency
Internal	Item Master Data	Customs tariff number (code)
Internal	Item Master Data	Multi-level BOM (bill of materials)
Internal	Item Master Data	Spare part number
Internal	Item Master Data	Supplier item number
Internal	Item Master Data	Value
Internal	Master Data Clients, Customers, Suppliers	Credit line
Internal	Multiple Clients	Storage of the stock of different clients in a storage bin
Internal	Multiple Warehouses	Automatic distribution of an order to multiple warehouses
Internal	Multiple Warehouses	Automatic distribution of individual order items at multiple warehouses
Internal	Multiple Warehouses	Manual distribution of individual order items at multiple warehouses
Internal	Multiple Warehouses	Procurement of supplies between two warehouses
Internal	Order Priority	Automatic time-dependent increase in the priority
Internal	Order Release	Backorder management
Internal	Order Release	Zero quantity acknowledgement
Internal	Picking Methods	Negative-picking
Internal	Picking Strategies	Pick for speed
Internal	Picking Strategies	Product pick order generation (discreet, linear, item load)
Internal	Printing Functions in Outbound	Production of goods issue papers depending on other criteria (such as sales, shipping, carrier ...)
Internal	Production Supply	At expiration of validity: automatic choice of substitution item at next call-off for expired item

Category B features

Internal	Production Supply	At expiration of validity: expired item is automatically blocked for picking
Internal	Production Supply	At expiration of validity: warning message at next call-off for expired item
Internal	Production Supply	Combination of delivery orders in one delivery to the production line (route planning)
Internal	Production Supply	Management of deliveries to the production line based on standard times per item
Internal	Production Supply	Management of deliveries to the production line based on standard times per item and point of use
Internal	Production Supply	Manual change of route planning
Internal	Production Supply	Registration of substitution item for item with limited validity
Internal	Production Supply	Report of all expired items
Internal	Production Supply	Validity period per item
Internal	Production Supply	Validity period per item and point of use
Internal	Put-away	Support the input and additional storage per load support with the different BBD
Internal	Put-away	Support the input and additional storage per loading devices with different lot numbers
Internal	Put-away	Support the placement strategy after charge storage
Internal	Put-away	Support the placement strategy after dangerous classes
Internal	Put-away	Support the placement strategy after handling capacity
Internal	Put-away	Support the placement strategy after Single item
Internal	Reactions on Shortages	Confirmation of the deliverable supply contract with provision of the non-deliverable part order
Internal	Reactions on Shortages	Confirmation of the deliverable supply contract with the rejection of the non-deliverable part order
Internal	Reactions on Shortages	Provision of jobs that can not be operated completely
Internal	Reactions on Shortages	Rejection of jobs that can not be operated completely
Internal	Relocations: Suggestions from the System	Early provision for the time near the point of outsourcing
Internal	Relocations: Suggestions from the System	The creation of open space by aggregation of a different article at a storage place
Internal	Replenishment	Automatic request of filling up of a commission area
Internal	Replenishment	Freely configurable replenishment strategies
Internal	Returns	Automatic introduction of required steps by the system in case of a return
Internal	Sequencing	Booking of goods issue for complete delivery (all parts on the rack)
Internal	Sequencing	Booking of goods issue for each part separately
Internal	Sequencing	Management of the sequence of parts in a special rack delivered to the production line
Internal	Sequencing	Picker gets information on mobile terminal about position of the part on the rack.
Internal	Shipping	Automatic carrier allocation for a tour
Internal	Shipping	Automatic handling equipment selection for a tour as depending on destination, shipping charges
Internal	Shipping	Determining the optimal dispatch at various criteria (eg, weight, delivery time, customer requirements ...)
Internal	Shipping	Manual handling equipment selection for a tour
Internal	Shipping Units Management	Display the shipping units belonging to a tour
Internal	Storage Place Information	Storage conditions for each product group
Internal	Storage Place Information	Storage conditions for each storage zone
Internal	Storage Place Information	Weights for each storage location
Internal	Transaction Logging	record of the BBD in the inventory movement log
Internal	Transaction Logging	Storage of the container type in the stock movement log
Internal	Transport Devices	Automatic collection of information on transportation, such as operating time, number of transfer orders, maintenance, incidents, ...
Internal	Transport Devices	Integrated stacker control system (ie, survey of current tasks and means of transport / resources, manual / automatic assignment of tasks to resources, prioritize tasks, review of overdue tasks, including basic ...)
Internal	Transport Devices	Management of information about transportation, such as type, max. Load / capacity, range of application, allowed items / load support, performance indicators etc.
Internal	Types of Inventory	In transit in distribution
Internal	Units of Measure	Create additional units possible
Internal	Warehouse Control	Double Play (combined input / retrieval)

Category C features

Business area	WMS Function	Feature
Automotive	Assembly	Assembly of the intermediates and then merge
Automotive	Assembly	Deposit multilevel BOMs
Automotive	Assembly	Deposit of a batch size of finished products / articles
Automotive	Assembly	Deposit of assembly instructions to various criteria, eg client, customer, order ...
Automotive	Assembly	Generation of transport requests for re-storage of the finished product / item
Automotive	Assembly	Multi-stage assembly of several assembly areas across
Automotive	Assembly	Stepwise viewing of assembly instructions
Automotive	Assembly	Storing the actual time needed for assembly
Automotive	Assembly	Two-stage deposit bills
Automotive	Assembly	View the assembly instructions
Automotive	Availability Check for Delivery Orders	Availability check in the light of duty-unpaid stock
Automotive	Blocking	Blocked by platform
Automotive	Blocking	Blocked by serial number range
Automotive	Blocking	Blocked by SSCC (Serial shipping container code)
Automotive	Building of Shipping Units	Calculating the number of required loading aids in the formation of shipping units
Automotive	Building of Shipping Units	Packaging management concerning different planes
Automotive	Building of Shipping Units	Packaging management concerning different types of pallets
Automotive	Building of Shipping Units	Packaging management concerning different types of rolling cages
Automotive	Building of Shipping Units	Selection of the loading medium for the formation of shipping units
Automotive	Building of Shipping Units	Specification of the picking sequence according to the formation of shipping units
Automotive	Customs	Booking of uncleared goods for sales orders
Automotive	Data Exchange with other Systems	Outward stock movement data
Automotive	Data Exchange with other Systems	Transport System
Automotive	Delivery Orders	Automatic conversion of units of the order item in stock customary units
Automotive	Dock & Yard Management	Automatic assignment of a truck at a dock in prioritization of urgently needed goods
Automotive	Dock & Yard Management	Deposit of targeted delivery times (inwards)
Automotive	Dock & Yard Management	Deposit of delivery target times (outwards)
Automotive	Dock & Yard Management	Dock and yard management features are available
Automotive	Dock & Yard Management	Is the system of the contents of the trucks known? (Linking a delivery truck with advices)
Automotive	Dock & Yard Management	Manual assignment of a truck at a dock
Automotive	Empties Handling	Cause of empties and Loading Equipment accounts per shipping address
Automotive	Empties Handling	Generating return pick-ups for empty / LCs
Automotive	Goods Issue	Support for controlling freight costs
Automotive	Inbound Preadvice (ASN)	best-before date (BBD)
Automotive	Inventory Management	Automatic suggestion of defined alternative products
Automotive	Inventory Process	Different time points for each inventory item
Automotive	Inventory Process	Prioritization of the inventory-related transportation contracts so that normal operation is not disturbed
Automotive	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by supplier
Automotive	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from supplier
Automotive	Invoicing / Billing of Warehouse Services	Generating invoices for the services provided by supplier
Automotive	Item Master Data	Charge field as a mandatory field
Automotive	Item Master Data	More than one currency
Automotive	Item Master Data	Multi-level BOM (bill of materials)
Automotive	Item Master Data	Spare part number
Automotive	Loading	Check the correct loading by manual entry of a check digit
Automotive	Loading	Check the correct loading of the check digit by scanning
Automotive	Master Data Clients, Customers, Suppliers	Billing Address
Automotive	Master Data Clients, Customers, Suppliers	Classifications (eg, payment behavior, delivery reliability, ...)
Automotive	Master Data Clients, Customers, Suppliers	Conditions / prices
Automotive	Master Data Clients, Customers, Suppliers	Credit line
Automotive	Master Data Clients, Customers, Suppliers	Invoicing in favor of customer
Automotive	Order Release	Automated order release criteria for utilization
Automotive	Order Release	Backorder management
Automotive	Order Release	Zero quantity acknowledgement

Category C features

Automotive	Part ID's	Management of Part ID's
Automotive	Part ID's	Registration of additional information for Part ID
Automotive	Picking	Rounding up/down for suitable pick quantity
Automotive	Picking Methods	Negative-picking
Automotive	Picking Methods	Picking waves
Automotive	Picking Order	Information providing means for picking Pick to Light
Automotive	Picking Strategies	Pick for speed
Automotive	Production Supply	Management of deliveries to the production line based on standard times per item
Automotive	Production Supply	Management of deliveries to the production line based on standard times per item and point of use
Automotive	Put-away	Support the input and additional storage per load support with the different BBD
Automotive	Put-away	Support the input and additional storage per loading devices with different lot numbers
Automotive	Put-away	Support the input and additional storage per loading equipment with the same batch number
Automotive	Put-away	Support the placement strategy after fairground system per item
Automotive	Put-away	Support the placement strategy after fairground system per item group / class
Automotive	Put-away	Support the placement strategy after handling capacity
Automotive	Put-away	Support the placement strategy after weight classes (heavy to the bottom, light above)
Automotive	Reactions on Shortages	Confirmation of the deliverable supply contract with the rejection of the non-deliverable part order
Automotive	Relocations: Suggestions from the System	Early provision for the time near the point of outsourcing
Automotive	Relocations: Suggestions from the System	The creation of open space by aggregation of a different article at a storage place
Automotive	Replenishment	Automatic request of filling up of a commission area
Automotive	Replenishment	Automatic request of filling up the supplies or spare area
Automotive	Replenishment	Freely configurable replenishment strategies
Automotive	Resource Planning	Transportation-related resource planning, taking account of the performance ratios of means of transport, availability of transport, the application range of means of transport
Automotive	Resource Planning	Transportation-related resources planning taking into account the standard time
Automotive	Returns	Automatic introduction of required steps by the system in case of a return
Automotive	Sample Check at Goods Receipt	Depositing a formula for calculating the sample size per item
Automotive	Sequencing	Booking of goods issue for complete delivery (all parts on the rack)
Automotive	Sequencing	Booking of goods issue for each part separately
Automotive	Sequencing	Management of the sequence of parts in a special rack delivered to the production line
Automotive	Sequencing	Picker gets information on mobile terminal about position of the part on the rack.
Automotive	Shipping	Determining the optimal dispatch at various criteria (eg, weight, delivery time, customer requirements ...)
Automotive	Shipping	Manual handling equipment selection for a tour
Automotive	Shipping Units Management	Display the shipping units belonging to a tour
Automotive	Storage Place Information	Weights for each storage column
Automotive	Storage Place Information	Weights for each storage zone
Automotive	Storage Place Information	Weights per storage row (aisle)
Automotive	Transaction Logging	record of the BBD in the inventory movement log
Automotive	Transaction Logging	Storage of the container type in the stock movement log
Automotive	Transport Devices	Automatic collection of information on transportation, such as operating time, number of transfer orders, maintenance, incidents, ...
Automotive	Transport Devices	Cause of transportation statistics (hours of use, frequency of use ,...)
Automotive	Transport Devices	Integrated stacker control system (ie, survey of current tasks and means of transport / resources, manual / automatic assignment of tasks to resources, prioritize tasks, review of overdue tasks, including basic ...)
Automotive	Transport Devices	Sequence optimization over several orders
Automotive	Transport Devices	Support a load-dependent transportation choice
Automotive	Transport Devices	Support a transportation choice
Automotive	Types of Inventory	In transit in distribution

Category C features

Automotive	Types of Inventory	In transit in procurement
Automotive	Warehouse Control	Double Play (combined input / retrieval)
Consumer / FMCG	Assembly	Automatic stock transfer after confirmation of the assembly and disassembly operations
Consumer / FMCG	Assembly	Deposit multilevel BOMs
Consumer / FMCG	Assembly	Deposit of a batch size of finished products / articles
Consumer / FMCG	Assembly	Deposit of assembly instructions to various criteria, eg client, customer, order ...
Consumer / FMCG	Assembly	Generation of transport requests for re-storage of the finished product / item
Consumer / FMCG	Assembly	Stepwise viewing of assembly instructions
Consumer / FMCG	Assembly	Storing the actual time needed for assembly
Consumer / FMCG	Assembly	Two-stage deposit bills
Consumer / FMCG	Assembly	View the assembly instructions
Consumer / FMCG	Availability Check for Delivery Orders	Availability check in the light of duty-unpaid stock
Consumer / FMCG	Blocking	Blocked by BBD (Best before date)
Consumer / FMCG	Blocking	Blocked by platform
Consumer / FMCG	Blocking	Blocked by product
Consumer / FMCG	Blocking	Blocked by serial number range
Consumer / FMCG	Blocking	Blocked by SSCC (Serial shipping container code)
Consumer / FMCG	Building of Shipping Units	Packaging management concerning different planes
Consumer / FMCG	Building of Shipping Units	Packaging management concerning different types of pallets
Consumer / FMCG	Building of Shipping Units	Packaging management concerning different types of rolling cages
Consumer / FMCG	Building of Shipping Units	Selection of the loading medium for the formation of shipping units
Consumer / FMCG	Building of Shipping Units	Specification of the picking sequence according to the formation of shipping units
Consumer / FMCG	Correction Bookings	Support for adjustment postings according to change in the batch number
Consumer / FMCG	Customs	Booking of uncleared goods for sales orders
Consumer / FMCG	Data Exchange with other Systems	Transport System
Consumer / FMCG	Dock & Yard Management	Automatic assignment of a truck at a dock in prioritization of urgently needed goods
Consumer / FMCG	Dock & Yard Management	Deposit of delivery target times (outwards)
Consumer / FMCG	Dock & Yard Management	Manual assignment of a truck at a dock
Consumer / FMCG	Empties Handling	Cause of empties and Loading Equipment accounts per shipping address
Consumer / FMCG	Empties Handling	Generating return pick-ups for empty / LCs
Consumer / FMCG	Goods Issue	Support for controlling freight costs
Consumer / FMCG	Inventory Management	Automatic suggestion of defined alternative products
Consumer / FMCG	Inventory Process	Different time points for each inventory item
Consumer / FMCG	Inventory Process	Prioritization of the inventory-related transportation contracts so that normal operation is not disturbed
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by supplier
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from supplier
Consumer / FMCG	Invoicing / Billing of Warehouse Services	Generating invoices for the services provided by supplier
Consumer / FMCG	Item Master Data	Charge field as a mandatory field
Consumer / FMCG	Item Master Data	More than one currency
Consumer / FMCG	Item Master Data	Multi-level BOM (bill of materials)
Consumer / FMCG	Item Master Data	Spare part number
Consumer / FMCG	Order Release	Automated order release criteria for utilization
Consumer / FMCG	Order Release	Backorder management
Consumer / FMCG	Order Release	Zero quantity acknowledgement
Consumer / FMCG	Part ID's	Management of Part ID's
Consumer / FMCG	Part ID's	Registration of additional information for Part ID
Consumer / FMCG	Picking	Rounding up/down for suitable pick quantity
Consumer / FMCG	Picking Order	Information providing means for picking Pick to Light
Consumer / FMCG	Picking Strategies	Pick for speed
Consumer / FMCG	Production Supply	Management of deliveries to the production line based on standard times per item
Consumer / FMCG	Production Supply	Management of deliveries to the production line based on standard times per item and point of use
Consumer / FMCG	Put-away	Support the input and additional storage per load support with the different BBD

Category C features

Consumer / FMCG	Put-away	Support the input and additional storage per loading devices with different lot numbers
Consumer / FMCG	Put-away	Support the input and additional storage per loading equipment with the same batch number
Consumer / FMCG	Put-away	Support the input and additional storage per loading equipment with the same BBD
Consumer / FMCG	Put-away	Support the placement strategy after fairground system per item
Consumer / FMCG	Put-away	Support the placement strategy after fairground system per item group / class
Consumer / FMCG	Put-away	Support the placement strategy after handling capacity
Consumer / FMCG	Put-away	Support the placement strategy after weight classes (heavy to the bottom, light above)
Consumer / FMCG	Reactions on Shortages	Confirmation of the deliverable supply contract with the rejection of the non-deliverable part order
Consumer / FMCG	Relocations: Suggestions from the System	Early provision for the time near the point of outsourcing
Consumer / FMCG	Replenishment	Automatic request of filling up the supplies or spare area
Consumer / FMCG	Replenishment	Freely configurable replenishment strategies
Consumer / FMCG	Resource Planning	Transportation-related resource planning, taking account of the performance ratios of means of transport, availability of transport, the application range of means of transport
Consumer / FMCG	Sample Check at Goods Receipt	Depositing a formula for calculating the sample size per item
Consumer / FMCG	Sequencing	Management of the sequence of parts in a special rack delivered to the production line
Consumer / FMCG	Sequencing	Picker gets information on mobile terminal about position of the part on the rack.
Consumer / FMCG	Shipping	Determining the optimal dispatch at various criteria (eg, weight, delivery time, customer requirements ...)
Consumer / FMCG	Shipping Units Management	Display the shipping units belonging to a tour
Consumer / FMCG	Storage Place Information	Weights for each storage column
Consumer / FMCG	Storage Place Information	Weights for each storage zone
Consumer / FMCG	Storage Place Information	Weights per storage row (aisle)
Consumer / FMCG	Transaction Logging	record of the BBD in the inventory movement log
Consumer / FMCG	Transaction Logging	Storage of the container type in the stock movement log
Consumer / FMCG	Transport Devices	Automatic collection of information on transportation, such as operating time, number of transfer orders, maintenance, incidents, ...
Consumer / FMCG	Transport Devices	Cause of transportation statistics (hours of use, frequency of use ,...)
Consumer / FMCG	Transport Devices	Integrated stacker control system (ie, survey of current tasks and means of transport / resources, manual / automatic assignment of tasks to resources, prioritize tasks, review of overdue tasks, including basic ...)
Consumer / FMCG	Transport Devices	Support a load-dependent transportation choice
Consumer / FMCG	Transport Devices	Support a transportation choice
Consumer / FMCG	Types of Inventory	In transit in distribution
Consumer / FMCG	Types of Inventory	In transit in procurement
Consumer / FMCG	Warehouse Control	Double Play (combined input / retrieval)
General warehouse	Availability Check for Delivery Orders	Availability check from the prospective portfolio
General warehouse	Availability Check for Delivery Orders	Availability check from the quality control population
General warehouse	Availability Check for Delivery Orders	Availability from the overall population
General warehouse	Comparison of ASN and Goods Receipt	Package-ID-Nr.
General warehouse	Comparison of ASN and Goods Receipt	Packaging scheme used
General warehouse	Customs	Deposit of duty ID for the entire delivery
General warehouse	Customs	Deposit of duty-ID for specific positions in the delivery
General warehouse	Inventory Management	Automatic generation of back-orders
General warehouse	Inventory Management	Automatic generation of missing list
General warehouse	Inventory Process	Inventory ignoring inactive parts
General warehouse	Item Master Data	Reorder level
General warehouse	Item Master Data	Reorder quantity
General warehouse	Item Master Data	Stackability of the item on the load carrier
General warehouse	Multiple Warehouses	Assignment of a supplier to a warehouse
General warehouse	Picking	Automatic assignment of a picking order to the closest commissioner
General warehouse	Picking Methods	Execution of collective orders (multiple orders, one picking)
General warehouse	Reactions on Shortages	Automatic activation of postponed orders for the new goods received
General warehouse	Relocations	Targeted voids of storage areas

Category C features

General warehouse	Relocations: Suggestions from the System	Early provision for the time near the point of outsourcing
General warehouse	Retrieval	Arrange the outsourced goods to be picked just before the dispatch time
General warehouse	Retrieval	Support automatic selection of alternative subject for outsourcing
General warehouse	Sample Check at Goods Receipt	Deposit a fixed sample size per item
General warehouse	Sample Check at Goods Receipt	Deposit a percentage of the sample size per item
General warehouse	Sample Check at Goods Receipt	Deposit of a client-specific sample size
General warehouse	Shipping units management	Restocking of the completed shipping units commissioned
General warehouse	Standard Forms / Printouts	Pro forma invoice (for clearing low-value items)
General warehouse	Types of Inventory	Stock aftercare
High-tech	Assembly	Deposit multilevel BOMs
High-tech	Assembly	Deposit of a batch size of finished products / articles
High-tech	Assembly	Deposit of assembly instructions to various criteria, eg client, customer, order ...
High-tech	Assembly	Generation of transport requests for re-storage of the finished product / item
High-tech	Assembly	Stepwise viewing of assembly instructions
High-tech	Assembly	Storing the actual time needed for assembly
High-tech	Assembly	Two-stage deposit bills
High-tech	Assembly	View the assembly instructions
High-tech	Availability Check for Delivery Orders	Availability check in the light of duty-unpaid stock
High-tech	Blocking	Blocked by BBD (Best before date)
High-tech	Blocking	Blocked by platform
High-tech	Blocking	Blocked by serial number range
High-tech	Blocking	Blocked by SSCC (Serial shipping container code)
High-tech	Building of Shipping Units	Calculating the number of required loading aids in the formation of shipping units
High-tech	Building of Shipping Units	Packaging management concerning different planes
High-tech	Building of Shipping Units	Packaging management concerning different types of pallets
High-tech	Building of Shipping Units	Packaging management concerning different types of rolling cages
High-tech	Building of Shipping Units	Selection of the loading medium for the formation of shipping units
High-tech	Building of Shipping Units	Specification of the picking sequence according to the formation of shipping units
High-tech	Correction Bookings	Support for adjustment postings according to change in the batch number
High-tech	Customs	Booking of uncleared goods for sales orders
High-tech	Data Exchange with other Systems	Outward stock movement data
High-tech	Data Exchange with other Systems	Transport System
High-tech	Delivery Orders	Automatic conversion of units of the order item in stock customary units
High-tech	Dock & Yard Management	Automatic assignment of a truck at a dock in prioritization of urgently needed goods
High-tech	Dock & Yard Management	Deposit of targeted delivery times (inwards)
High-tech	Dock & Yard Management	Deposit of delivery target times (outwards)
High-tech	Dock & Yard Management	Dock and yard management features are available
High-tech	Dock & Yard Management	Is the system of the contents of the trucks known? (Linking a delivery truck with advices)
High-tech	Dock & Yard Management	Manual assignment of a truck at a dock
High-tech	Empties Handling	Cause of empties and Loading Equipment accounts per shipping address
High-tech	Empties Handling	Generating return pick-ups for empty / LCs
High-tech	Goods Issue	Support for controlling freight costs
High-tech	Inbound Preadvice (ASN)	best-before date (BBD)
High-tech	Inventory Management	Automatic suggestion of defined alternative products
High-tech	Inventory Process	Different time points for each inventory item
High-tech	Inventory Process	Prioritization of the inventory-related transportation contracts so that normal operation is not disturbed
High-tech	Invoicing / Billing of Warehouse Services	Deposit of prices for services
High-tech	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by supplier
High-tech	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from supplier
High-tech	Invoicing / Billing of Warehouse Services	Generating invoices for the services provided by supplier
High-tech	Item Master Data	Charge field as a mandatory field
High-tech	Item Master Data	More than one currency

Category C features

High-tech	Item Master Data	Multi-level BOM (bill of materials)
High-tech	Item Master Data	Spare part number
High-tech	Loading	Check the correct loading by manual entry of a check digit
High-tech	Loading	Check the correct loading of the check digit by scanning
High-tech	Multiple Clients	Storage of the stock of different clients in a storage bin
High-tech	Order Release	Automated order release criteria for utilization
High-tech	Order Release	Zero quantity acknowledgement
High-tech	Part ID's	Management of Part ID's
High-tech	Part ID's	Registration of additional information for Part ID
High-tech	Picking	Rounding up/down for suitable pick quantity
High-tech	Picking Methods	Picking waves
High-tech	Picking Order	Information providing means for picking Pick to Light
High-tech	Picking Strategies	Pick for speed
High-tech	Printing Functions in Outbound	Production of goods issue papers depending on other criteria (such as sales, shipping, carrier ...)
High-tech	Production Supply	Management of deliveries to the production line based on standard times per item
High-tech	Production Supply	Management of deliveries to the production line based on standard times per item and point of use
High-tech	Put-away	Support the input and additional storage per load support with the different BBD
High-tech	Put-away	Support the input and additional storage per loading devices with different lot numbers
High-tech	Put-away	Support the input and additional storage per loading equipment with the same batch number
High-tech	Put-away	Support the placement strategy after charge storage
High-tech	Put-away	Support the placement strategy after fairground system per item group / class
High-tech	Put-away	Support the placement strategy after handling capacity
High-tech	Put-away	Support the placement strategy after weight classes (heavy to the bottom, light above)
High-tech	Reactions on Shortages	Confirmation of the deliverable supply contract with the rejection of the non-deliverable part order
High-tech	Relocations: Suggestions from the System	Early provision for the time near the point of outsourcing
High-tech	Replenishment	Automatic request of filling up of a commission area
High-tech	Replenishment	Automatic request of filling up the supplies or spare area
High-tech	Replenishment	Freely configurable replenishment strategies
High-tech	Resource Planning	Transportation-related resource planning, taking account of the performance ratios of means of transport, availability of transport, the application range of means of transport
High-tech	Sample Check at Goods Receipt	Depositing a formula for calculating the sample size per item
High-tech	Sequencing	Booking of goods issue for each part separately
High-tech	Sequencing	Management of the sequence of parts in a special rack delivered to the production line
High-tech	Sequencing	Picker gets information on mobile terminal about position of the part on the rack.
High-tech	Shipping	Determining the optimal dispatch at various criteria (eg, weight, delivery time, customer requirements ...)
High-tech	Shipping	Manual handling equipment selection for a tour
High-tech	Shipping Units Management	Display the shipping units belonging to a tour
High-tech	Storage Place Information	Weights for each storage column
High-tech	Storage Place Information	Weights for each storage zone
High-tech	Storage Place Information	Weights per storage row (aisle)
High-tech	Transaction Logging	record of the BBD in the inventory movement log
High-tech	Transaction Logging	Storage of the container type in the stock movement log
High-tech	Transport Devices	Automatic collection of information on transportation, such as operating time, number of transfer orders, maintenance, incidents, ...
High-tech	Transport Devices	Cause of transportation statistics (hours of use, frequency of use ,...)
High-tech	Transport Devices	Integrated stacker control system (ie, survey of current tasks and means of transport / resources, manual / automatic assignment of tasks to resources, prioritize tasks, review of overdue tasks, including basic ...)
High-tech	Transport Devices	Support a load-dependent transportation choice
High-tech	Transport Devices	Support a transportation choice
High-tech	Types of Inventory	In transit in distribution

Category C features

High-tech	Warehouse Control	Double Play (combined input / retrieval)
Industrial	Assembly	Deposit multilevel BOMs
Industrial	Assembly	Deposit of a batch size of finished products / articles
Industrial	Assembly	Deposit of assembly instructions to various criteria, eg client, customer, order ...
Industrial	Assembly	Generation of transport requests for re-storage of the finished product / item
Industrial	Assembly	Stepwise viewing of assembly instructions
Industrial	Assembly	Storing the actual time needed for assembly
Industrial	Assembly	Two-stage deposit bills
Industrial	Assembly	View the assembly instructions
Industrial	Availability Check for Delivery Orders	Availability check in the light of duty-unpaid stock
Industrial	Blocking	Blocked by platform
Industrial	Blocking	Blocked by serial number range
Industrial	Blocking	Blocked by SSCC (Serial shipping container code)
Industrial	Building of Shipping Units	Calculating the number of required loading aids in the formation of shipping units
Industrial	Building of Shipping Units	Packaging management concerning different planes
Industrial	Building of Shipping Units	Packaging management concerning different types of pallets
Industrial	Building of Shipping Units	Packaging management concerning different types of rolling cages
Industrial	Building of Shipping Units	Selection of the loading medium for the formation of shipping units
Industrial	Building of Shipping Units	Specification of the picking sequence according to the formation of shipping units
Industrial	Correction Bookings	Support for adjustment postings according to change in the batch number
Industrial	Customs	Booking of uncleared goods for sales orders
Industrial	Data Exchange with other Systems	Outward stock movement data
Industrial	Data Exchange with other Systems	Transport System
Industrial	Delivery Orders	Automatic conversion of units of the order item in stock customary units
Industrial	Dock & Yard Management	Automatic assignment of a truck at a dock in prioritization of urgently needed goods
Industrial	Dock & Yard Management	Deposit of targeted delivery times (inwards)
Industrial	Dock & Yard Management	Deposit of delivery target times (outwards)
Industrial	Dock & Yard Management	Dock and yard management features are available
Industrial	Dock & Yard Management	Is the system of the contents of the trucks known? (Linking a delivery truck with advices)
Industrial	Dock & Yard Management	Manual assignment of a truck at a dock
Industrial	Empties Handling	Cause of empties and Loading Equipment accounts per shipping address
Industrial	Empties Handling	Generating return pick-ups for empty / LCs
Industrial	Goods Issue	Support for controlling freight costs
Industrial	Inventory Management	Automatic suggestion of defined alternative products
Industrial	Inventory Process	Different points in time inventory for each client
Industrial	Inventory Process	Different time points for each inventory item
Industrial	Inventory Process	Prioritization of the inventory-related transportation contracts so that normal operation is not disturbed
Industrial	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by supplier
Industrial	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from supplier
Industrial	Invoicing / Billing of Warehouse Services	Generating invoices for the services provided by supplier
Industrial	Item Master Data	Charge field as a mandatory field
Industrial	Item Master Data	More than one currency
Industrial	Item Master Data	Spare part number
Industrial	Loading	Check the correct loading by manual entry of a check digit
Industrial	Loading	Check the correct loading of the check digit by scanning
Industrial	Multiple Clients	Storage of the stock of different clients in a storage bin
Industrial	Order Release	Automated order release criteria for utilization
Industrial	Order Release	Zero quantity acknowledgement
Industrial	Part ID's	Management of Part ID's
Industrial	Part ID's	Registration of additional information for Part ID
Industrial	Picking	Rounding up/down for suitable pick quantity
Industrial	Picking Methods	Picking waves
Industrial	Picking Order	Information providing means for picking Pick to Light
Industrial	Picking Strategies	Pick for speed

Category C features

Industrial	Production Supply	Management of deliveries to the production line based on standard times per item
Industrial	Production Supply	Management of deliveries to the production line based on standard times per item and point of use
Industrial	Put-away	Support the input and additional storage per load support with the different BBD
Industrial	Put-away	Support the input and additional storage per loading devices with different lot numbers
Industrial	Put-away	Support the input and additional storage per loading equipment with the same batch number
Industrial	Put-away	Support the placement strategy after dangerous classes
Industrial	Put-away	Support the placement strategy after fairground system per item
Industrial	Put-away	Support the placement strategy after fairground system per item group / class
Industrial	Put-away	Support the placement strategy after handling capacity
Industrial	Put-away	Support the placement strategy after weight classes (heavy to the bottom, light above)
Industrial	Reactions on Shortages	Confirmation of the deliverable supply contract with the rejection of the non-deliverable part order
Industrial	Relocations: Suggestions from the System	Early provision for the time near the point of outsourcing
Industrial	Replenishment	Automatic request of filling up of a commission area
Industrial	Replenishment	Automatic request of filling up the supplies or spare area
Industrial	Replenishment	Freely configurable replenishment strategies
Industrial	Resource Planning	Transportation-related resource planning, taking account of the performance ratios of means of transport, availability of transport, the application range of means of transport
Industrial	Resource Planning	Transportation-related resources planning taking into account the standard time
Industrial	Sample Check at Goods Receipt	Depositing a formula for calculating the sample size per item
Industrial	Sequencing	Booking of goods issue for each part separately
Industrial	Shipping	Determining the optimal dispatch at various criteria (eg, weight, delivery time, customer requirements ...)
Industrial	Shipping	Manual handling equipment selection for a tour
Industrial	Shipping Units Management	Display the shipping units belonging to a tour
Industrial	Storage Place Information	Weights for each storage column
Industrial	Storage Place Information	Weights for each storage zone
Industrial	Storage Place Information	Weights per storage row (aisle)
Industrial	Transaction Logging	record of the BBD in the inventory movement log
Industrial	Transaction Logging	Storage of the container type in the stock movement log
Industrial	Transport Devices	Automatic collection of information on transportation, such as operating time, number of transfer orders, maintenance, incidents, ...
Industrial	Transport Devices	Cause of transportation statistics (hours of use, frequency of use ,...)
Industrial	Transport Devices	Integrated stacker control system (ie, survey of current tasks and means of transport / resources, manual / automatic assignment of tasks to resources, prioritize tasks, review of overdue tasks, including basic ...)
Industrial	Transport Devices	Sequence optimization over several orders
Industrial	Transport Devices	Support a load-dependent transportation choice
Industrial	Transport Devices	Support a transportation choice
Industrial	Types of Inventory	In transit in distribution
Industrial	Warehouse Control	Double Play (combined input / retrieval)
Internal	Assembly	Assembly of the intermediates and then merge
Internal	Assembly	Deposit multilevel BOMs
Internal	Assembly	Multi-stage assembly of several assembly areas across
Internal	Assembly	Update of installation using the standard time-related activities carried out
Internal	Blocking	Blocked by platform
Internal	Building of Shipping Units	Calculating the number of required loading aids in the formation of shipping units
Internal	Building of Shipping Units	Formation of shipping units to the loading equipment-specific requirements (eg, weight limit)
Internal	Building of Shipping Units	Packaging management concerning different planes
Internal	Building of Shipping Units	Selection of the loading medium for the formation of shipping units
Internal	Building of Shipping Units	Specification of the picking sequence according to the formation of shipping units

Category C features

Internal	Customs	Booking of uncleared goods for sales orders
Internal	Dock & Yard Management	Automatic assignment of a truck at a dock in prioritization of urgently needed goods
Internal	Dock & Yard Management	Automatic assignment of a truck at a dock in the light of target times
Internal	Dock & Yard Management	Automatic assignment of a truck at a dock with route optimization
Internal	Dock & Yard Management	Dock and yard management features are available
Internal	Empties Handling	Cause of empties and Loading Equipment accounts per customer
Internal	Empties Handling	Generating return pick-ups for empty / LCs
Internal	Inventory Management	Automatic suggestion of defined alternative products
Internal	Inventory Management	Generation of orders for various methods
Internal	Inventory Process	Different points in time inventory for each client
Internal	Inventory Process	Different time points for each inventory item
Internal	Inventory Process	Prioritization of the inventory-related transportation contracts so that normal operation is not disturbed
Internal	Invoicing / Billing of Warehouse Services	Determination of the warehouse services provided by supplier
Internal	Invoicing / Billing of Warehouse Services	Different prices for identical services depending of from supplier
Internal	Invoicing / Billing of Warehouse Services	Generating invoices for the services provided by supplier
Internal	Item Master Data	Charge field as a mandatory field
Internal	Kanban	Management of electronic Kanban cycles
Internal	Kanban	Management of paper-based Kanban cycles
Internal	Order Release	Automated order release criteria for utilization
Internal	Part ID's	Management of Part ID's
Internal	Part ID's	Registration of additional information for Part ID
Internal	Picking	Rounding up/down for suitable pick quantity
Internal	Picking Order	Information providing means for picking Pick to Light
Internal	Put-away	Support the input and additional storage per loading equipment with the same batch number
Internal	Put-away	Support the input and additional storage per loading equipment with the same BBD
Internal	Put-away	Support the placement strategy after equal distribution of items in stock areas such as alleys
Internal	Put-away	Support the placement strategy after fairground system per item
Internal	Put-away	Support the placement strategy after fairground system per item group / class
Internal	Put-away	Support the placement strategy after weight classes (heavy to the bottom, light above)
Internal	Relocations: Suggestions from the System	Equal distribution of items in stock areas
Internal	Replenishment	Automatic request of filling up the supplies or spare area
Internal	Resource Planning	Transportation-related resource planning, taking account of the performance ratios of means of transport, availability of transport, the application range of means of transport
Internal	Resource Planning	Transportation-related resources planning taking into account the standard time
Internal	Retrieval	Support automatic selection of alternative subject for outsourcing
Internal	Sample Check at Goods Receipt	Deposit of a vendor-specific sample size
Internal	Sample Check at Goods Receipt	Depositing a formula for calculating the sample size per item
Internal	Shipping	Manual carrier mapping for a Tour
Internal	Storage Place Information	Weights for each storage column
Internal	Storage Place Information	Weights per storage row (aisle)
Internal	Transport Devices	Cause of transportation statistics (hours of use, frequency of use ,...)
Internal	Transport Devices	Sequence optimization over several orders
Internal	Transport Devices	Support a load-dependent transportation choice
Internal	Transport Devices	Transport management is available
Internal	Transport Devices	Support a transportation choice